

THE GENUS *POSTICOBIA*
(MOLLUSCA: CAENOCASTROPODA: RISSOOIDEA: HYDROBIIIDAE S.L.)
FROM AUSTRALIA AND NORFOLK ISLAND

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ABSTRACT

The freshwater gastropod genus *Posticobia* Iredale, 1943, is found predominately in eastern Australia and is redefined using morphological and anatomical characters. The genus is found in a wide range of habitats from isolated springs in central Australia to the large coastal rivers and lakes of New South Wales and Queensland. The genus as currently recognised is considered to contain three species, *Posticobia brazieri* (E. A. Smith, 1882) from eastern Australia, ***Posticobia ponderi*** n. sp. from Mulligan Springs, South Australia, and *Posticobia norfolkensis* (Sykes, 1900) from Norfolk Island.

Key words: Hydrobiidae, *Posticobia*, anatomy, taxonomy, morphology, Australia.

INTRODUCTION

The dominant group of freshwater gastropod molluscs in Australia is the Hydrobiidae, with over 180 currently named taxa (Smith et al., 2002). (The use of this family name for the Australasian taxa is currently under review and is here used in the broad sense, following Ponder et al., 2008.) However, based on the range of forms present in Australian museum collections and unpublished genetic data, this figure represents only a fraction of the true Australian hydrobiid fauna. This highly speciose group can be found in virtually all freshwater habitats, from small high mountain streams (Clark et al., 2003) to isolated springs in the arid interior (Ponder et al., 1996) to caves in southern Tasmania (Ponder et al., 2005). The bulk of the known species are narrow range endemics (Harvey, 2002; Ponder & Colgan, 2002), with small to very small distributions and live in habitats that do not allow easy access for such passive dispersal agents as birds or fish. Consequently, there is a tendency towards local endemism; examples include *Beddomeia* Petterd, 1889, *Fluvidona* Iredale, 1937, and *Austropyrgus* Cotton, 1942 (Ponder et al., 1993; Miller et al., 1999; Clark et al., 2003). On the other hand, genera that do live in such relatively open and therefore accessible habitats as coastal rivers and lakes tend

to have few species with large distributions; examples include *Littoridinops* Pilsbry, 1952, *Hydrobia* Hartmann, 1821 (Thompson, 1999; Wilke & Davis, 2000), and one of the species dealt with herein.

Posticobia has a wide, largely coastal distribution in the eastern half of Australia (Fig. 1), inhabiting freshwater springs, streams, rivers, and lakes down to the freshwater-brackish water interface. It occurs from the Northern Territory, east across northern Queensland and south to Sydney, central New South Wales, with scattered populations in southeastern South Australia and isolated populations in western Victoria, northeastern South Australia, and western Queensland. Outside of the Australian mainland, the genus has been recorded from Norfolk Island, with *Posticobia norfolkensis* (Sykes, 1900). However, this form now appears to be extinct (Ponder, 1981), and along with *Beddomeia tumida* Petterd, 1889, from Tasmania (Ponder et al., 1993), have the dubious distinction of being the only named Australian hydrobiids to be reported as extinct.

Posticobia is typically very abundant and can reach extremely high densities, sometimes in the order of 100,000s per square metre, as was observed in the Wilson River at Banglow Rd., N of Lismore in 1993. When extremely high population densities were observed, the streams had very high water quality with intake

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riparian vegetation. Therefore, when very high densities are present, it appears to be a good indicator of stream health. However, very little is known of the biology of *Posticobia*, or of most other Australian hydrobiids. Casual observations, however, suggest that *Posticobia brazieri* may breed throughout much of the year due to the presence of egg capsules and juveniles of various sizes at different times of the year, and because their reproductive systems usually appear to be mature irrespective of the season.

The taxonomy of the genus is typical of the early reliance on shell characters as a means of classification. Smith (1882) named a distinctive species of freshwater snail collected by John Brazier from the Clarence River, at Grafton, northern New South Wales, as *Hydrobia brazieri*. Subsequently, *Amnicola positura* from Lismore, northern New South Wales, was proposed (Petterd, 1884). No further forms were named until 1943, when Iredale considered *Hydrobia brazieri* to be so distinctive in shell shape and in the possession of a keel on the last whorl, that he erected the genus *Posticobia*. Further, he named an additional species, *Posticobia chena*, from the stomach of a duck shot at Chichester Dam, near Dungog, central New South Wales. *Paludestrina norfolkensis* Sykes, 1900, from Norfolk Island (approximately 1,650 km ENE of Sydney), was included by Ponder (1981) in the *Posticobia* on the basis of the similarity of its shell, opercular, and radular characters to those of *Posticobia brazieri*. Ponder & Clark (1990) suggested *Posticobia* was a subgenus of the widespread genus *Austropyrgus* Cotton (= *Fluvidona* Iredale, as it was then recognised). Smith (1992) listed *Posticobia* as a full genus with two valid species *P. brazieri* and *P. norfolkensis*. A recent molecular study (Perez et al., 2005) suggested that *Posticobia* is a valid genus sister to *Austropyrgus*.

The purpose of the present study was to clarify the taxonomic status of *Posticobia* and to determine whether the morphological variation exhibited by *Posticobia* represents a single widespread variable species or a complex of several species using shell, radula and anatomical characters.

MATERIALS AND METHODS

Collection

Specimens used for anatomy and allozymes were collected between May 1992 and October

1994 by washing specimens from the surface of the substratum, such as stones, wood or roots, and using a hand sieve to sweep aquatic vegetation along the edges of springs, small streams, rivers and lakes. Where samples allowed, part was frozen and the rest was fixed in 10% formalin buffered with sodium bicarbonate and then transferred to 5% buffered formalin. Samples were obtained from across the mainland range of *Posticobia* (Fig. 1). However, attempts to recollect specimens from western Victoria were unsuccessful.

Subsamples of specimens were measured, dissected and mounted for SEM using standard protocols (e.g., Ponder et al., 1989; Clark et al., 2003). The material used is housed in the institutions listed below under abbreviations. A discriminant analysis based on the shell measurements (SH, SW, AH, BW, CV, TW) was run using MYSTAT 12 ver. 12.02 2007 (SYSTAT Software Inc., Richmond, California, USA).

Allozyme Electrophoresis

Twenty populations (Clark, 1997) were examined electrophoretically using Titan III cellulose acetate plate electrophoresis and were scored for 21 loci. Clark (1997) listed the loci examined, the running conditions and the alleles observed for each population. Results were analysed with BIOSYS-1 (Swofford & Selander, 1981, 1989). However, due to the small sample sizes for most of the populations examined, the question as to how many species may be represented was poorly resolved. Therefore, these results are not presented here.

ABBREVIATIONS

Collections: AMS – Australian Museum, Sydney, New South Wales, Australia (material listed from AMS has the prefix C.); MV – Museum of Victoria, Melbourne, Victoria, Australia; NMNZ – National Museum of New Zealand, Wellington, New Zealand; NHML, The Natural History Museum, London, England; QM – Queensland Museum, Brisbane, Australia; SAM – South Australian Museum, Adelaide, South Australia, Australia.

Shell and Opercular Measurements: AH – aperture height; BW – body whorl height, CV – convexity ratio; OL operculum length; OW – operculum width; OSL – opercular smear length; OSW – opercular smear width; SH – shell height; SW – shell width, TW – number of body whorls.

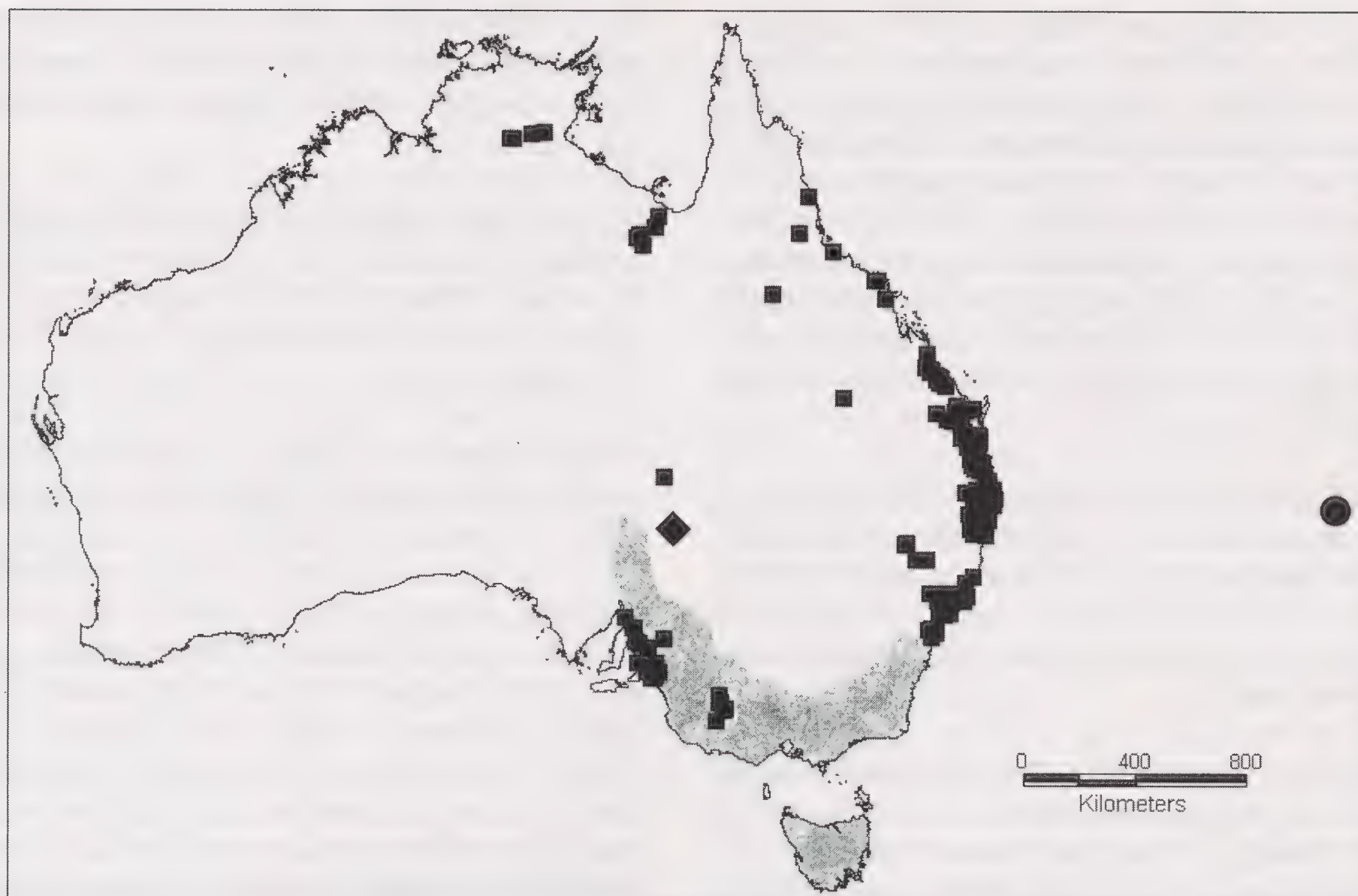


FIG. 1. Distribution of *Posticobia*. ■ – *P. brazieri*; ◆ – *P. ponderi*; ● – *P. norfolkensis*. The shaded area represents the known range of *Austropyrgus*.

Anatomical Figures: ag – albumen gland; bc – bursa copulatrix; bd – bursal duct; ca – caecum; cg – capsule gland; co – coiled oviduct; dgo – digestive gland opening; go – genital opening; in – intestine; os – oesophagus; pe – penis; pg – prostate gland; pw – pallial wall; sd – seminal receptacle duct; sr – seminal receptacle; ss – style sac; st – stomach; vc – ventral channel; vd – vas deferens.

Geographic Terms: Ave. – Avenue; ca. – approximately; Cr. – Creek; Dr. – Drive; Hwy. – Highway; Mt. – Mount; NP – National Park; Rd. – Road; Ri. – River; SF – State forest.

TAXONOMY

Family Hydrobiidae
Subfamily Tateinae

Classification follows Bouchet & Rocroi (2005) and Ponder et al. (2008).

Genus *Posticobia* Iredale, 1943

Posticobia Iredale, 1943: 204. Type species: *Hydrobia brazieri* Smith, 1882, by original designation.

Diagnosis

Shell ovate to broadly conical; sutures slightly to well impressed; body whorl convex to strongly keeled, smooth. Operculum flat, paucispiral, yellow, with a white smear and 2–5 (typically 2–3) weakly developed pegs on inner surface. Radula with 3–4 (typically 4) basal cusps on central teeth. Penis simple, tapering; prostate gland closed, more or less kidney-shaped, with pallial vas deferens emerging from just before pallial wall on ventral side. Female genital system with simple, inverted U-shaped proximal coiled oviduct and short distal coiled oviduct with single bend. Pallial oviduct with opening overlapping anterior end of capsule gland.

Description

Shell – Shell small to medium-sized for family, 1.37–3.31 mm in height, 1.18–2.82 mm in width, ovate to broadly conical in shape; spire of average height, outline convex; sutures slightly to well impressed. Aperture 0.68–1.52 mm in height, oval, not disjunct from last whorl. Teleoconch of 2.25–4.30 convex whorls, body whorl 1.08–2.42 mm in height, last whorl evenly convex to sub-shouldered, keel absent to well developed. Teleoconch sculpture smooth, with

fine to coarse growth lines. Inner lip of aperture firmly adhering to parietal wall to slightly separated from parietal wall. Outer lip weakly thickened to heavily thickened, lacking external varix, not reflected. Umbilicus partially open to narrow in adults, narrowly open in juveniles. Colour opaque, yellowish-brown, periostracum thin, may impart darker colour. Protoconch of about 0.85–1.30 whorls; sculptured with sparsely to densely distributed irregular shallow pits.

Operculum – Ovate, thin, flat, yellow, horny, paucispiral, with eccentric nucleus, 0.65–1.47 mm in length, 0.51–1.06 mm in width. White smear 0.06–0.57 mm in length, 0.03–0.40 mm in width; up to 5 weakly developed pegs on inner side.

Radula – Typical of subfamily. Central teeth with 4–5 lateral cusps, median cusp of medium width, sharply pointed and about 2 times longer than adjacent cusps; 3–4 pairs of basal cusps; basal tongue U-shaped, just protruding past lateral edge. Lateral teeth: with 4–5 cusps on each side, medium cusp of medium width, sharply pointed and about 2 times longer than adjacent cusps; basal projection U-shaped, lateral flange longer than cutting edge. Inner marginal teeth with 21–31 cusps, on distal and outer sides of each tooth, inner side smooth. Outer marginal teeth with 25–35 cusps, on distal and inner sides of each tooth, outer side smooth.

External Features – Typical of subfamily. Animal pigmentation variable, from weakly to well developed (grey to black), cephalic tentacles long, slender, slightly tapering, with narrow, median-dorsal unpigmented line (corresponding to line of dorsal cilia). Snout with some cilia dorsally, with narrow, well-developed band laterally and latero-dorsally just behind labia. Tentacles with well-developed, mid-dorsal and two ventro-lateral strips of cilia.

Mantle Cavity – Typical of subfamily. Ctenidium with 19–32 triangular filaments (width at widest point 0.12–0.39 mm), apices near right side, posterior end abutting pericardium. Osphradium 0.22–0.66 mm in length, white, elongately oval, located between posterior end and middle of ctenidium. Hypobranchial gland inconspicuous to well developed, partly to completely covering rectum. Rectum straight or with weakly developed arch (arch more developed in males). Visceral coil: Renal organ (as mainly seen from renal gland) extends forward ca.

1/3–1/2 into pallial cavity, orientated longitudinally. Renal gland 0.28–0.72 mm in length and 0.16–0.34 mm in width. Pericardium more than 1/2 in pallial roof.

Stomach – Similar to other members of subfamily. Stomach 0.33–0.74 mm in length, style sac 0.22–0.67 mm in length with a very small to small gastric caecum, 0.02–0.17 mm in length.

Male Genital System – Similar to other members of subfamily. Testis occupying about 1.0–1.5 whorls. Seminal vesicle beneath anterior 1/4 to 1/2 of first whorl of testis behind stomach, loosely to tightly coiled over stomach, conspicuously coiled on both digestive gland and testis behind stomach. Prostate gland 0.40–0.73 mm in length, 0.17–0.34 mm in width, about 1/3 to 2/3 in pallial roof, kidney-shaped, oval to compressed-oval in section. Pallial vas deferens flush with surface of neck, slightly to strongly undulating from prostate gland to base of penis. Penis unpigmented, distal part short and tapering, base broad, creased (when at rest). Penial duct strongly undulating in base, straight in distal portion of penis. Penis located just to right of midline, 0.22–0.56 mm behind right eye.

Female Genital System – Similar to other members of subfamily. Ovary simple, occupying about 0.75–1.40 whorls. Coiled oviduct with initial U-shaped bend orientated obliquely backwards; initial loop high to medium; proximal part simple; distal part straight or with one bend distal to seminal receptacle. Coiled oviduct and bursal duct joining just behind pallial wall with oviduct joining bursal duct from right side. Oviduct straight, before joining with bursal duct. Bursal duct 0.04–0.12 mm in length, 0.07–0.15 mm in width, parallel sided, straight. Seminal receptacle located on or near anterior edge of bursa copulatrix to towards middle of inner wall of bursa copulatrix. Bursa copulatrix 0.22–0.55 mm in length, 0.16–0.33 mm in width. Seminal receptacle 0.09–0.22 mm in length, 0.06–0.13 mm in width, pyriform in shape to a narrow sac with short duct. Rectum overlapping both albumen and capsule glands. Albumen gland 0.22–0.51 mm in length, 0.22–0.43 mm in width, about 1/2 to 2/3 of albumen gland in front of posterior pallial wall. Capsule gland 0.31–0.90 mm in length, 0.18–0.35 mm in width, with anterior end tapering to blunt, oval to compressed-oval in section, with distinct glandular zones. Ventral channel indistinct to distinct, with indistinct to

moderate sized muscular vestibule. Genital opening small to medium in length, overlapping anterior end of capsule gland.

Egg Capsules – Egg capsules small, 0.30–0.40 mm in diameter, hemispherical in shape. They contain a single egg and are usually a greenish-yellow colour. They are found attached to various substrata, such as sand grains and vegetation or, rarely, attached to the shell of other individuals or other molluscs. They have been found in most samples collected during the length of this project.

Distribution

Posticobia is distributed in the eastern half of Australia and Norfolk Island (Fig. 1); it is found predominately in the streams and rivers flowing east along the coastal ranges, with a number of scattered populations found in parts of inland New South Wales, Victoria, Queensland, Northern Territory, and South Australia. *Posticobia* is found in a wide range of aquatic habitats from coastal lakes, such as the Myall Lakes of central New South Wales, coastal rivers and streams to isolated desert springs, such as Mulligan Springs in northern South Australia. There appears to be a large gap in distribution from Sydney south to Victoria west of Melbourne, where *Posticobia* appears to be replaced by the closed related genus *Austropyrgus* Cotton, 1942 (Clark et al., 2003; Perez et al., 2005). Where *Posticobia* occurs it is normally abundant and can be found crawling on all substrata, such as aquatic plants, wood, sand, gravel and rocks. *Posticobia* can be found sympatrically with *Fluvidona* Iredale, 1937, and *Jardinella* Iredale & Whitley, 1938, in northern New South Wales and southern Queensland, *Austropyrgus* in New South Wales and South Australia, *Tatea* Tenison Woods, 1879, and *Ascorhis* Ponder & Clark, 1988, in the Myall Lakes New South Wales.

Remarks

Posticobia is a member of a group of Australasian genera related to the estuarine genus *Tatea* Tenison Woods, 1879. Since its original description, *Posticobia* has been treated as a valid genus (Iredale, 1943, 1944; Ponder, 1981; Smith, 1992) or as a subgenus of *Fluvidona* of authors (= *Austropyrgus*) (Ponder & Clark, 1990). Some of the similarities that *Posticobia* shares with *Tatea* and related genera are 3–4 pairs of basal cusps on the central tooth, the

presence of pegs (albeit rudimentary in *Posticobia*) on the inner surface of the operculum, and a simple, tapering penis.

Posticobia differs from *Fluvidona* in a number of characters, including its shell shape (pupiform in *Fluvidona*), the possession of a gastric caecum (lacking in *Fluvidona*), the oviduct joins the bursal duct ventrally (dorsally in *Fluvidona*), the yellow colour of the operculum (red in *Fluvidona*), and the poorly developed opercular pegs (well developed in *Fluvidona*). Allozymically the two genera are very different, with 17 fixed differences separating the two (Clark, 1997). *Posticobia* differs from *Austropyrgus* by its shell shape (pupiform to elongated conical), the opercular pegs are poorly developed (well developed in *Austropyrgus*), and the coiled oviduct is positioned just on the anterior edge of the bursa copulatrix near the albumen gland (it lies across more than half the lower portion of the bursa in *Austropyrgus*). Allozymically the two genera are more closely related to one another than either are to *Fluvidona*, with four fixed differences separating the two (Clark, 1997). *Posticobia* can be easily distinguished from other Australasian hydrobiid genera by its general shell shape, although there is some superficial resemblance to some species of *Beddomeia* Petterd, 1889, which occur only in Tasmania, outside the range of *Posticobia*. *Jardinella* differs from *Posticobia* in a number of characters including its shape, having only two pairs of basal cusps on the central tooth and having a no pegs or only a white smear present on the inner side of the operculum.

Posticobia can be found from slightly brackish waters, such as those of the Myall Lakes to small isolated springs in arid areas of South Australia and Queensland. The New Zealand hydrobiid genus *Potamopyrgus* Stimpson, 1865, shows similar wide tolerances from fresh-water to brackish water (Haase, 2008).

Posticobia brazieri (E. A. Smith, 1882)
Figures 1–4, 7–10, 13, 14, 17–20, 23, 24,
27–35

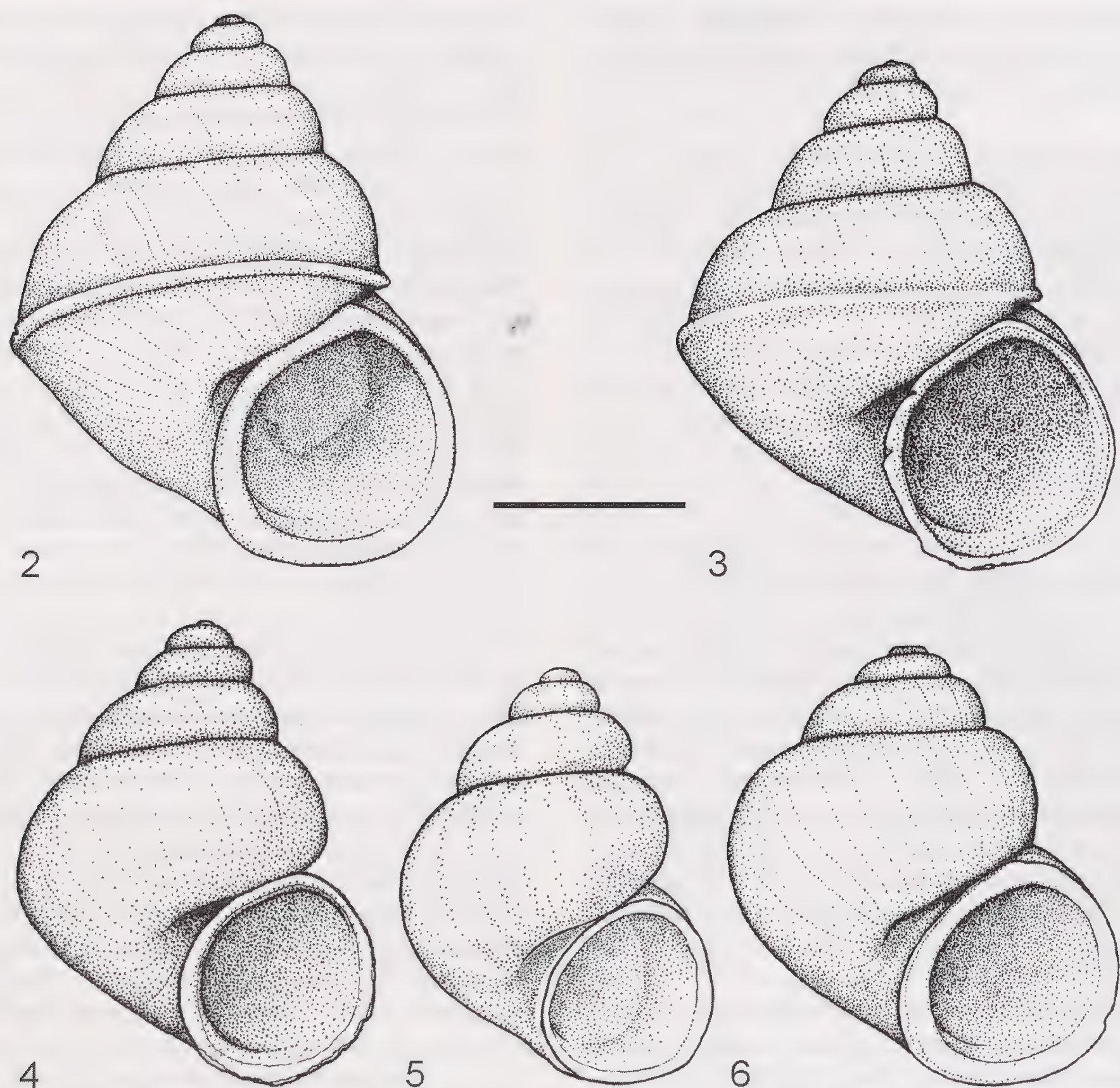
Hydrobia brazieri E. A. Smith, 1882: 269, pl. 7, fig. 21; Brazier, 1889: 72; Hedley & Musson, 1892: 563.

Amnicola positura Petterd, 1884: 159.

Amnicola carinata Brazier, 1889: 72 (*nom. nud.*).

Petterdiana brazieri – Hedley, 1904: 184; Hedley, 1915: 716.

Posticobia chena Iredale, 1943: 204; Iredale, 1944: 115, text-fig.



FIGS. 2–6. *Posticobia* species. FIGS. 2–4: *P. brazieri*; FIG. 2: Syntype of *Hydrobia brazieri* (BMNH 1879.5.21.369-378); FIG. 3: Syntype of *Amnicola positura* (C.19919); FIG. 4: Syntype of *Posticobia chena* (C.100582); FIG. 5: Holotype of *P. ponderi* (C.461157); FIG. 6: *P. norfolkensis*; Syntype of *Paludestrina norfolkensis* (BMNH 1856.10.27.94). Scale bar = 1 mm.

Posticobia brazieri – Iredale, 1943: 204; Iredale, 1944: 115; Ponder, 1981: 17, 18, fig. 2, 6–8; Smith, 1992: 53, 54; Ponder et al., 2000.
Fluvidona (Posticobia) cf. *brazieri* – Ponder & Clark, 1990: 348.

Type Material

Syntypes NHML 1879.5.21.369-378 (65); syntypes NHML 1886.12.3.36-45 (15), in G. A. Angas Collection.

Type Locality

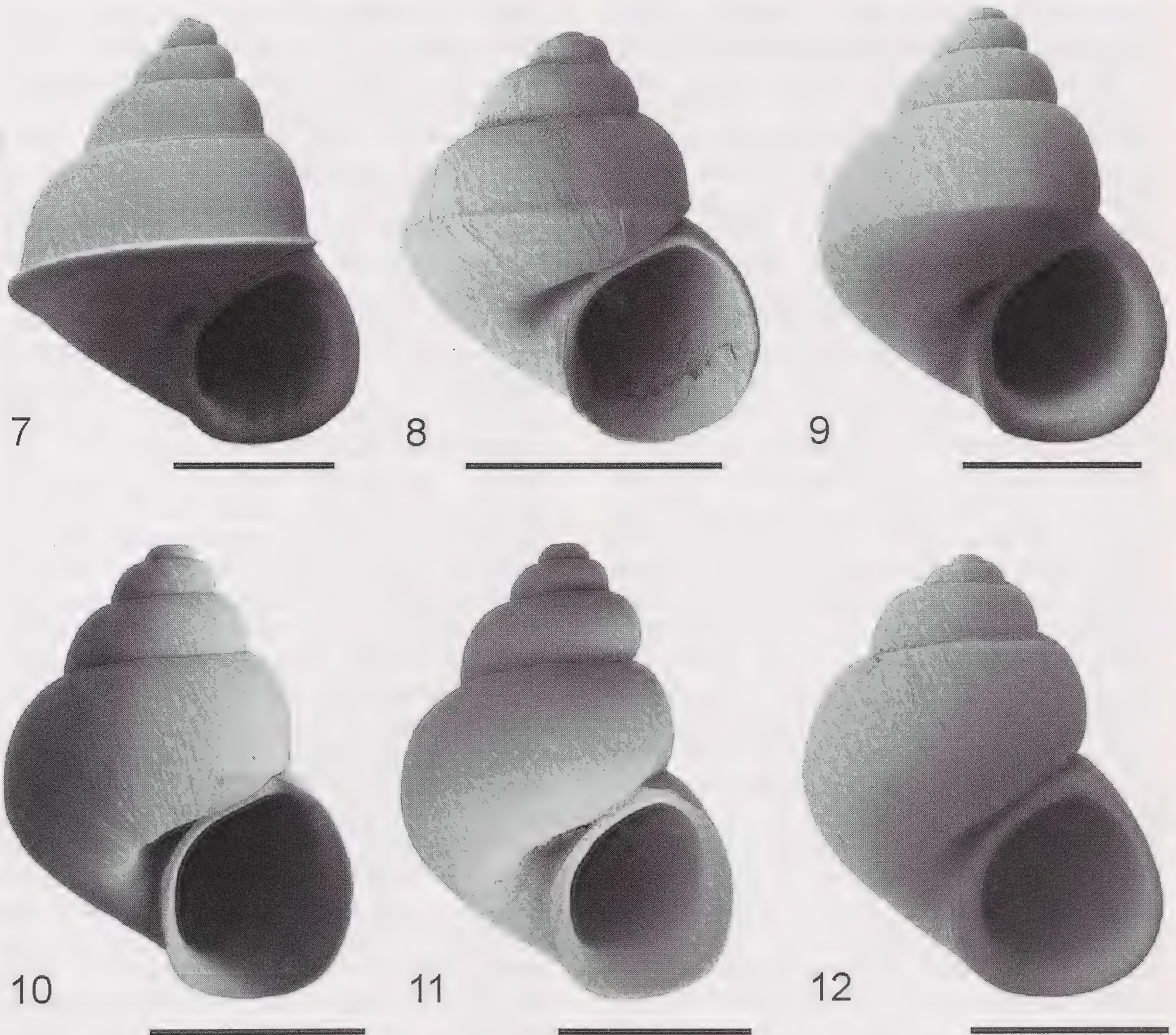
In freshwater creek, Clarence Ri., South Grafton, New South Wales, Australia, 1879, J. Brazier.

Type Material of Synonyms

Amnicola positura, syntypes C.19919 (4), Richmond Ri., near Lismore, NSW, W. F. Petterd; *Posticobia chena*, syntypes C.100582 (1), C.200849 (many), Chichester Dam, Hunter, NSW.

Material Dissected

Northern Territory – Mulura Rapids, Roper Ri. at Elsie Park, 14°56'40"S, 133°12'22"E, 27 Aug. 1994 (C.201826); *Queensland* Ban Ban Springs, off Burnett Hwy., E of Gayndah, 25°41'06"S, 151°48'54"E, 29 May 1992 (C.203019); *New South Wales* – Clarence Ri., on N bank, about 1 km upstream of bridge,



FIGS. 7–12. *Posticobia* species. FIGS. 7–10: *P. brazieri*; FIG. 7: North bank of Clarence River, Grafton, New South Wales (C.203018); FIG. 8: Mungo Brush, Myall Lakes, New South Wales (C.203021); FIG. 9: Murray River, Murray Bridge, South Australia (C.203022); FIG. 10: Roper River, Elsie Park, Northern Territory (C.203024); FIG. 11: *P. ponderi* Mulligan Springs, Lake Callabonna, South Australia (C.203023); FIG. 12: *P. norfolkensis* Norfolk Island, New South Wales (C.203025). Scale bars = 1 mm.

Grafton, 29°41'50"S, 152°56'05"E, 11 Mar. 1993 (C.203025); Mungo Brush, Myall Lakes NP., N of Hawks Nest, 32°32'33"S, 152°18'33"E, 10 Jan. 1993 (C.203028); Halfway Point, Lane Cove Ri., Lane Cove River NP., Chatswood West, Sydney, 33°47'29"S, 151°08'47"E, 13 Sept. 1992, S.4008 (C.203029); *South Australia* – Murra Ri. at Murray Bridge, 35°07'18"S, 139°16'53"E 30 May 1993 (C.203034).

Material Examined

Northern Territory – Roper Ri. at Roper Bar camping ground, 14°42'42"S, 134°30'46"E, 20 May 1997 (C.331884); Roper Ri. at Rocky Bar

Crossing, Roper Valley Station, 14°44'13"S, 134°02'58"E, 22 Aug. 1995 (C.202314); 40 m above Elsie Falls, Roper Ri., 14°55'05"S, 133°07'04"E, 20 Aug. 1994 (C.201825); Elsie Falls at Roper Ri., 14°55'05"S, 133°07'03"E, 20 Aug. 1994 (C.410923); Mulurak Rapids, Roper Ri. at Elsie Park, 14°56'40"S, 133°12'22"E, 27 Aug. 1994 (C.201826, C.327897); *Queensland* – Tributary of Flaggy Cr., Little Mulgrave Ri., on Little Mulgrave Rd. ca. 4 km from Gillies Hwy., 17°07'23"S, 145°41'46"E, 28 Apr. 1998 (C.381712); Little Mulgrave Ri. at base of escarpment, 17°08'30"S, 145°44'23"E, 5 June 1997 (C.326804); Beames Brook, SW of Burketown, 17°52'43"S,

139°20'34"E, 28 May 1997 (C.346421); Running creek on Gregory Downs-Burketown Rd., 40 km N of Gregory Downs and about 5 km S of Almora Station, 18°19'24"S, 139°15'49"E, 28 May 1997 (C.410921); Burdekin Ri., 18°30'S, 145°19'58"E, 15 Nov. 1983 (C.142292); 2 km downstream from waterhole behind Lawn Hill Station homestead, 18°34'02"S, 138°35'08"E, 26 May 1997 (C.346420); Lawn Hill Cr. within 1 km of National Park ranger station, 18°42'S, 138°29'E, 26 May 1997 (C.410919); Gregory Ri. on Riversleigh-Lawn Hill Rd., 19°01'06"S, 138°43'33"E, 27 May 1997 (C.331855); Three Mile Cr., Palarenda, Townsville, 19°12'37"S, 146°46'30"E, 23 Feb. 1997 (C.331874); Myrtle Cr., crossing No 1 at Bruce Hwy., ca. 5 miles N of Proserpine, 20°21'S, 148°33'E, 4 May 1975 (C.200815); Pine Tree Cr. Lagoon, Hughenden, 20°51'S, 144°11'58"E, 12 June 1983 (C.200887); Keppel Bay, Yeppoon, 23°07'58"S, 150°45'E (C.200860); Double Cr., SW of Calliope, 24°02'54"S, 151°09'E, 8 May 1992 (C.203017); Boyne Ri. at Rosedale, S of Gladstone, 24°13'40"S, 151°15'28"E, 5 Sept. 1982 (C.200881); Skeleton Cr. at Bruce Hwy., N of Miriam Vale, 24°19'16"S, 151°32'18"E, 7 May 1992 (C.203018); Double Cr. at Dawson Hwy., SW of Gladstone, 24°45'S, 151°08'13"E, 5 Sept. 1982 (C.200810); Belinda Springs, Salvador Rosa Section, Carnarvon Gorge NP., 24°50'S, 147°11'45"E, 29 Sept. 1984 (C.156794, C.157168); Burnett Ri., 25°04'58"S, 152°00'E (C.011019, QM MO.26518); Burnett Ri. at Causeway Rd., N of Booyal, S of Gin Gin, 25°13'45"S, 152°42'E, Sept. 1982, July 1997 (C.200808, C.410915); Isis Ri. at Bruce Hwy., S of Childers, 25°16'08"S, 152°22'23"E, 9 May 1975 (C.200818); Burnett Ri. at Trurick Cr., W of Childers, 25°18'38"S, 151°56'15"E, 3 Sept. 1982 (C.200809); Eidsvold, 25°23'S, 151°08'E, 1912 (C.033769); Woowoonga Stream at Childers-Biggenden Rd., W of Childers, 25°28'S, 151°59'58"E, 4 Sept. 1970 (C.440028); Burnett Ri., E of Gayndah, 25°37'S, 151°36'E, 25 Apr. 1975 (C.200816); Eel Cr. at Biggenden-Maryborough Rd., ca. 20 km E of Biggenden, 25°37'S, 152°10'E, 8 July 1980 (QMMO.26529); Ban Ban Springs, off Burnett Hwy., E of Gayndah, 25°40'51"S, 151°48'56"E, 1982–2000 (C.200790, C.425869, C.203019, C.302414); Wide Bay Cr., NW of Gympie, 26°04'S, 152°14'48"E, 2 Sept. 1982 (C.200806, C.362225); Fat Hen Cr. at Wide Bay Hwy., 26°05'23"S, 152°17'15"E, 11 Sept. 2000 (C.386127); Widgie Cr. at Reids Rd., W of Gympie, 26°11'15"S, 152°28'45"E, 7 Sept.

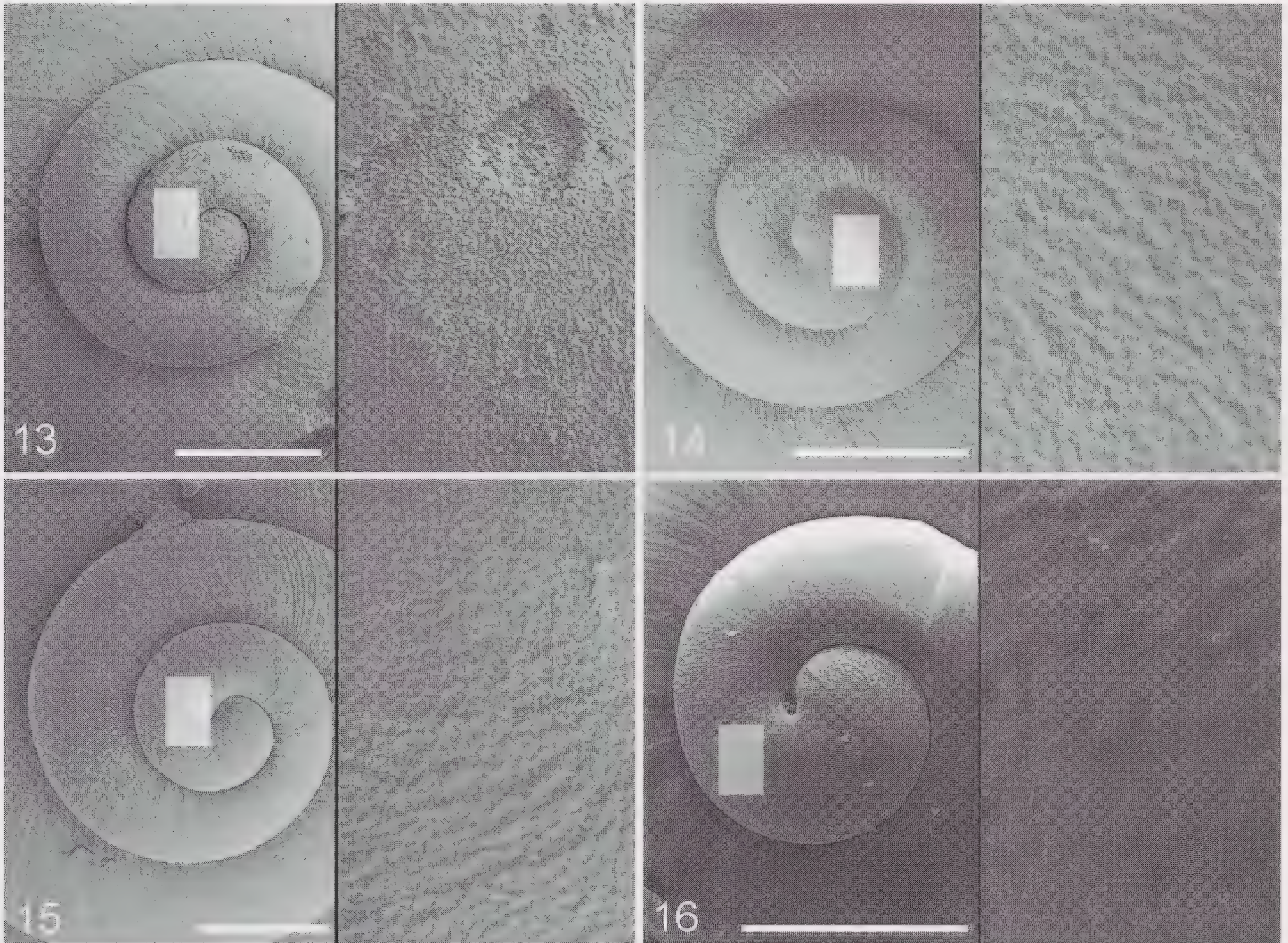
1982 (C.200883); Eel Cr., SW of Gympie, 26°13'49"S, 152°37'52"E, 7 Sept. 1982 (C.200811); small stream 9.5 km from Myravale Forest Station, Glastonbury SF, W of Gympie, 26°14'49"S, 152°29'30"E, 7 Sept. 1982 (C.200880); tributary of Marys Cr., SW of Gympie, 26°16'01"S, 152°32'52"E, 7 Sept. 1982 (C.200812); Barambah Cr. at Central Burnett Hwy., E of Gayndah, 26°19'58"S, 152°11'58"E, Apr. 1975, Sept. 1982 (C.200819, C.200805); Skyring Cr. at Amama Picnic ground in Amamoor SF, 26°21'46"S, 152°38'04"E, 7 May 1998 (C.410918); Eumundi, Templeton Property, 26°29'25"S, 152°57'12"E, 30 Sept. 2003 (C.456847); Derrier Cr. at Imbil Forest Dr., 26°30'23"S, 152°37'56"E, 7 May 1998 (C.410920); Coonoon Cr. at Gibber Rd., in Brooloo SF, S of Gympie, 26°32'30"S, 152°41'30"E, 7 Sept. 1982 (C.200814); Old Coonon Gibber Cr., Brooloo SF, SW of Gympie, 26°34'45"S, 152°40'E, 7 Sept. 1982 (C.200813); Picnic Cr., above walking track at or near edge of Kondalilla NP, 26°40'18"S, 152°52'05"E, 6 May 1998 (C.401222); tributary of Little Yabba Cr., 4.4 km S of Jimna, 26°41'35"S, 152°24'21"E, 8 Mar. 1993 (C.203020); Neunum Cr., just off Somerset Dam, N of Brisbane, 27°01'08"S, 152°41'51"E, 30 Aug. 1982 (C.200826); North Pine Ri., 1 km S of Mt. Pleasant, SW of Caboolture, 27°09'45"S, 152°46'28"E, 30 Aug. 1982 (C.200882); Dayboro, Brisbane, 27°10'S, 152°50'E, 11 Aug. 1976 (QM); tributary of Laceys Cr. at Laceys Creek Rd., 27°11'45"S, 152°45'15"E, 30 Aug. 1982 (C.200825); tributary of North Pine Ri., Dayboro, NW of Petrie, 27°13'04"S, 152°49'58"E, 10 May 1975 (C.200840); Cedar Cr. at Dayboro-Samford Rd., 27°13'58"S, 152°43'58"E, 10 May 1975 (C.200843); Rush Cr. at Dayboro Rd., 10 km NW of Petrie, 27°13'58"S, 152°53'58"E, 20 Jan. 1981 (C.200885); North Pine Ri., Dayboro, Brisbane, 27°15'S, 152°50'E, 11 Aug. 1976 (QM); Lower Pine Ri., 27°16'58"S 153°01'E (C.200862); North Pine Ri., Brisbane, 27°16'S, 152°58'58"E, 1912, Aug. 1979 (C.200859, C.200861, C.033713); North Pine Ri. at Dayboro-Samford Rd., 2 miles S of Dayboro, 27°19'58"S, 152°52'E, 10 May 1975 (C.200841); North Pine Ri. at Stafford Rd., LHS of bridge, 2 km W of Dayboro, 27°19'S, 152°52'58"E, 20 Jan. 1981 (C.200886); Cedar Cr., Closeburn, Brisbane, 27°20'S, 152°50'E, 11 Aug. 1976 (QM); South Pine Ri. at Dayboro-Samford Rd., 1 mi N of Samford, 27°22'S, 152°52'58"E, 10 May 1975 (C.200842); Kedran Brook, Brook St., Brisbane, 27°23'58"S, 152°58'E, 1 Aug.

1976 (C.200838, QM); Brisbane Ri., McFarlanes Bridge, near Bryden, between Northbrook & Esk, 27°23'S, 152°37'E, 20 Jan. 1981 (QM); Dawson Cr. at "Goat Track", near Mt. Nebo, W of Brisbane, 27°24'S, 152°47'50"E, 9 Mar. 1993 (C.203021); Enoggera Cr. at Ashgrove, Brisbane, 27°28'S, 153°00'E, 27 Dec. 1981 (C.200867); Indooroopilly, Brisbane, 27°28'S, 153°02'E (QM MO.26525); Kenmore, Brisbane, 27°30'S, 152°50'E, 15 Aug. 1976 (QM); Moggill Cr., Brookfield, 27°30'S, 152°56'E, Aug. 1976 (QM); Mt. Crosby, Brisbane, 27°30'S, 152°45'E, 15 Aug. 1976 (QM); Moggill Cr., Brisbane, 27°31'58"S, 152°55'58"E, July 1958, Feb. 1984 (C.200837, C.142291); Moggill Cr., Brookfield, Brisbane, 27°32'S, 152°56'E, 31 Oct. 1949 (QM MO.26517); Moggill & Gold Crs., Brookfield, Brisbane, 27°32'S, 152°56'E, 8 Apr. 1951 (QM MO.26519); Nerang Ri., Latimers Crossing, S of Nerang, 28°01'33"S, 153°17'51"E, 30 May 1992 (C.203022); in gully beside picnic area, Numinbah Valley SF, 28°07'33"S, 153°13'45"E, 17 Dec. 1980 (QM MO.26520); Waterfall Cr., junction of Springbrook Rd. and road to Numinbah Valley, 28°06'29"S, 153°14'38"E, 18 Mar. 1981 (C.128694); New Year (Tartars) Cr., 3 km from junction with Levers Plateau Rd., ENE of Woodenbong, 28°17'25"S, 152°50'50"E, 17 Mar. 1981 (C.200830); *New South Wales* – S end of Cudgen Lake, 28°19'39"S, 153°33'28"E, 27 Mar. 1998 (C.339281); Hoffmans Cr. at Woodenbong-Wylie Creek Rd., 28°25'58"S, 152°23'58"E, 9 Sept. 1982 (C.200828); tributary of Hoffmans Cr., Hewetsons Hill, ca. 14 km E of Legume, 28°25'59"S, 152°23'32"E, 15 Mar. 1981 (C.128692); Burringbar Cr. at Pacific Hwy., 48 km S of Tweed Heads, 28°26'19"S, 153°28'30"E, 18 Oct. 1976 (C.200836); Oakey Cr., W of Legume, 28°26'30"S, 152°22'58"E, 9 Sept. 1982 (C.200827); ford at Byrrill Creek Rd., Pretty Gully, N of Nimbin, 28°26'36"S, 153°14'30"E, 19 Mar. 1981 (C.200831); tributary of Byrrill Creek at Mebbin Forest Rd., 1 km from Byrrill Creek Rd. junction, Mebbin SF, 28°26'38"S, 153°11'48"E, 20 Mar. 1981 (C.128696); Hoffmans Cr., 800 m N of Tooloom turnoff at Hewetsons Mill at Mt. Lindsay Hwy., SE of Warwick, 28°26'S, 152°23'36"E, 15 Mar. 1981 (C.200768); Richmond Ri. at Kyogle, 28°36'52"S, 152°59'21"E, 9 May 1997 (C.428867); Taylors Lake, via Byron Bay, 28°37'30"S, 153°36'E, 22 July 1976 (C.200835); Horse Station Cr. at Omagh Rd., SW of Kyogle, 28°38'57"S, 152°58'40"E, 12 Aug. 1991 (C.167445); tributary of Peacock Creek at Peacock Creek Rd., 2.3 km S of Sandy Cr. Forest Rd., NE of Bo-

nalbo, 28°41'11"S, 152°41'49"E, 14 Mar. 1981 (C.200829); tributary of Richmond Ri. at Edenville Rd., NW of Casino, 28°43'54"S, 152°57'59"E, 12 Aug. 1991 (C.167448); Boorie Cr. at Bentley Rd., N of Lismore, 28°45'58"S, 153°17'05"E, 11 Mar. 1993 (C.203023); Lagoon Cr. at Summerland Way, Fairy Hill, N of Casino, 28°46'08"S, 152°59'06"E, 12 Aug. 1991 (C.167655); Wilson Ri. at Banglow Rd., 7 km NE of Lismore, NSW 28°46'49"S, 153°19'54"E, 11 Mar. 1993 S.5072 (C.203024); in small stream, below foot bridge, Rotary Park, Lismore, 28°48'42"S, 153°17'43"E, Oct.–Dec. 1993 (C.201405, C.201404); in a small stream, Wilsons Nature Reserve, Lismore, 28°50'04"S, 153°17'11"E, 16 Dec. 1993 (C.200899); Wyrallah Rd., Wilson Nature Reserve, Lismore, 28°50'S, 153°17'30"E, 15 Dec. 1998 (C.364918); Richmond Ri., Casino, 28°52'S, 153°34'E, 1970–1982 (C.200869, C.200824, C.200823); Richmond Ri., near & above Lismore, 28°59'S, 153°16'E, 1882 (C.019919); Richmond Ri., Woodburn, 29°04'30"S, 153°20'30"E, 17 Oct. 1976 (C.200832); Tuckombil Canal at Pacific Hwy., S of Woodburn, 29°05'S, 153°20'18"E, 26 Mar. 1998 (C.338933); Clarence Ri. at Baryulgil crossing, S of Tabulum, 29°13'01"S, 152°33'42"E, 28 Aug. 1982 (C.200821); Washpool Cr., 5.3 km S along Washpool Rd. from Lionsville Rd. turnoff, Washpool SF, SW of Casino, 29°13'37"S, 152°28'56"E, 29 Aug. 1982 (C.200822); Clarence Ri., 0.8 km E of Maclean, 29°27'S, 153°12'28"E, 18 Oct. 1972 (C.200834); Blue Pools near Angourie, 5 km S of Yamba, 29°28'45"S, 153°21'48"E, Sept. 1982–1984 (C.200889, C.200839); Ingalbar Cr. at Jackadgery Rd., NW of Grafton, 29°34'13"S, 152°33'46"E, 27 Aug. 1982 (C.200820); Clarence Ri. at Jackadgery Rd., 1 km W of Lilydale, 40 km W of Grafton, 29°34'58"S, 152°33'E, 4 Feb. 1981 (C.200884); Coldstream Ri. at Tucabia, 29°40'02"S, 153°06'16"E, 26 Mar. 1998 (C.338935); in swamp, Clarence Ri., South Grafton, 29°40'S, 152°55'58"E, 1900 (C.200865); Clarence Ri. at South Grafton, 29°40'S, 152°55'58"E, 1877 (C.200866); Clarence Ri., ca. 1 km upstream of bridge, Grafton, 29°41'49"S, 152°35'07"E, 11 Mar. 1993 (C.203018); Clarence Ri., South Grafton, 29°42'02"S, 152°56'26"E, 1870, 1912 (C.55145, C.200863); stream running into Clarence Ri., Grafton, 29°42'S, 152°55'58"E, 1914 (C.200864); Nymboida Ri., N bank on Old Glen Innes Rd., near Buccarumbi, NW of Nymboida, 29°50'13"S, 152°35'07"E, 12 Mar. 1993 (C.203026); Corindi Ri., 30°01'19"S, 153°11'31"E, 26 Mar. 1998 (C.338934); Namoi

Ri. at Tarriaro Bridge, on Narrabri-Turrawan Rd., 30°22'S, 149°51'28"E, 14 June 1975 (C.200833); Sandy Cr., S of Narrabri, 30°23'46"S, 149°48'57"E, 1887 (C.391747); Namoi Ri. near Gunnedah, 30°58'23"S, 150°15'16"E, 1967 (C.200868); Peel Ri., Bective near Tamworth, 30°58'58"S, 150°43'58"E, 1880's (C.309885); Kendall near Wauchope, 31°37'58"S, 152°42'28"E (C.200850); Manning Ri., Wingham Brush, W of Taree, 31°52'15"S, 152°22'51"E, 26 Aug. 1982 (C.200844); stream, 3 km S of Coolongolook Ri. crossing on edge of Pacific Hwy., S of Taree, 32°15'29"S, 152°19'25"E, 26 Aug. 1982 (C.200888); Muscle Cr. at Bell St. bridge crossing, Muswellbrook, 32°16'15"S, 150°52'39"E, 24 May, 27 June 2003 (C.456333, C.456331); Muscle Cr. at New England Hwy., between pedestrian overpass bridges at collapsed weir, ca. 2 km E of Muswellbrook, 32°16'47"S, 150°54'19"E, 24 May 2003 (C.456340); Muscle Cr. at New England Hwy., behind Pinaroo Caravan Park, ca. 2 km E of Muswellbrook, 32°16'53"S, 150°54'27"E, 14 May 2001 (C.456346); Muscle Cr. at Muswellbrook, 32°16'S, 150°54'E, 18 Sept. 1996 (C.360245); Williams Ri. between railway bridge and road bridge beside park, Dungog, 32°23'47"S, 151°45'45"E, 15 Feb. 2003 (C.421945, C.456342); Myall Lakes, 2 km W of Smith Lake, 32°23'S, 152°26'E, 16 Jan. 1964 (C.200848); Fal Brook at Goorangoola Rd., Mt. Pleasant, N of Singleton, 32°24'37"S, 151°11'36"E, 30 May 1903, 1 Dec 1999 (C.456344, C.456337); Myall Ri. at Bulahdelah, 32°24'54"S, 152°12'21"E, 1 Nov. 1992 (C.203027); Bulahdelah, 32°25'S, 152°12'E, 1925, 1994 (C.200870, C.200871); Bombah Point, near ferry, Bombah Broadwater, Myall Lakes NP, 32°30'20"S, 152°18'17"E, 13 Feb. 1989 (C.200851); Wattle Ponds at Bridgemans Rd., Hunterview, N of Singleton, 32°32'27"S, 151°10'06"E, 24 Sept. 2001 (C.456339); Blackfellows Bay, Mungo Brush, Myall Lakes NP, 32°32'36"S, 152°18'21"E, 13 Feb. 1989 (C.300610); Singleton, 32°34'S, 151°10'E, 1924 (C.51765); along Stony Cr. at edge of Uffington SF, behind Clarence Town Cemetery, off Cemetery Rd., NW of Newcastle, 32°35'13"S, 151°45'37"E, 10 Jan. 2002 (C.456349); creek at Nelson Rd., under bridge beside railway station, Greta, 32°41'12"S, 151°23'04"E, 19 June 2001 (C.456334); Black Cr. at Old North Rd., Rothbury, NW of Newcastle, 32°42'45"S, 151°19'25"E, 20 June 2001 (C.456347); nature reserve next to oval, University of Newcastle, Callaghan, 32°53'40"S, 151°42'05"E, Aug. 1999,

Sept. 2000 (C.456343, C.456348); tributary of Wallis Cr., ca 500 m upstream from Wallis Cr. junction, N of Sandy Creek Rd. crossing, Bow Wow Gorge, 5 km SW of Mulbring, 32°55'37"S, 151°26'24"E, 20 Sept. 2003 (C.456335); tributary of Wallis Cr., N of Sandy Creek Road crossing, Bow Wow Gorge, 5 km SW of Mulbring, 32°55'40"S, 151°26'23"E, 20 Sept. 2003 (C.456336); behind inlet weir of small creek beside scout hall, Kotara Park, Kotara, 32°56'34"S, 151°41'46"E, 2 Aug. 2003 (C.456338); Flaggy Cr. at track above waterfall, Glenrock State Recreational Area, Highfields, 32°57'36"S, 151°43'46"E, 11 Aug. 1999 (C.456341); Congewai Cr. at Congewai Rd., Congewai, 32°57'53"S, 151°16'10"E, 8 Mar. 2003 (C.456332); S end of Dudley Beach, Glenrock State Recreational Area, Dudley, 32°58'55"S, 151°43'37"E, 26 Aug. 1999 (C.456345); small creek behind Redhead Beach Caravan Park, S of Newcastle, 33°01'S, 151°42'28"E, 25 Dec. 1991 (C.200872); Dora Cr., Cooranbong, 33°04'58"S, 151°26'58"E, 5 Apr. 1975 (C.200845); Cattai Cr. between crossings of Cattai Ridge & Newman Rds., Maraylya, 33°34'57"S, 150°56'22"E, 5 Aug. 1994 (C.320653); Cattai Cr. at Cattai Ridge Rd., Maraylya, 33°35'01"S, 150°56'23"E, 3 Oct. 1994 (C.321254); Cattai Cr., upstream side of McClymonts Rd., Maraylya, 33°37'01"S, 150°55'39"E, 3 Oct. 1994 (C.321262); South Cr., upstream of Blighs Park/South Windsor STP outfall, Blighs Park, 33°38'30"S, 150°49'19"E, 24 July 1995 (C.309218); Lane Cove Ri., Lane Cove River State Recreation Area, Halfway Point picnic area, Chatswood West, Sydney, 33°47'16"S, 151°08'55"E, Feb. 1993, Oct. 1994 (C.320244, C.321280); Cabramatta Cr., between Hume Hwy. & railway line, Liverpool, Sydney, 33°54'17"S, 150°56'30"E, Aug. 1973, Nov. 1991 (C.200846, C.320700); Cabramatta Cr., Mt. Pritchard, Sydney, NSW, 33°54'18.5"S, 150°55'15"E, 8 Aug. 1992 (C.203030); Cabramatta Cr., Irelands Bridge Reserve, W of Hume Hwy., Warwick Farm, Sydney, 33°54'17.5"S, 150°56'37"E, 18 June 1989, 11 Oct. 1992 (C.200847, C.203031); Georges Ri. at Newbridge Rd., Liverpool, 33°55'46"S, 150°55'41"E, 13 Nov. 1994 (C.320661, C.321551); Georges Ri. at Cambridge Ave. causeway, Glenfield, 33°58'22"S, 150°54'38"E, 8 Jan. 1995 (C.320714); *Victoria* Wimmera Ri., 1 km NW of Jeparit, 36°09'S, 141°58'59"E, 10 Sept. 1977 (NMV F.54797); Wimmera Ri., Jeparit, 36°09'S, 141°58'59"E, 26 May 1978 (NMV F.54801); Wimmera Ri., 2 mi W of Dimboola, 36°27'S,



FIGS. 13–16. Protoconchs of *Posticobia* species. FIGS. 13, 14: *P. brazieri*; FIG. 13: North bank of Clarence River, Grafton, New South Wales; FIG. 14: Mungo Brush, Myall Lakes, New South Wales; FIG. 15: *P. ponderi* Mulligan Springs, Lake Callabonna, South Australia; FIG. 16: *P. norfolkensis* Norfolk Island, New South Wales. Right hand portion of figures shows detail of protoconch microsculpture (x8). Scale bar = 200 μ m.

142°02'E, Apr. 1971 – Apr. 1972 (C.200853, NMV, NMV F.54743); Wimmera Ri., downstream of Dimboola Ri., 36°27'S, 142°00'E, 5 May 1986 (C.200856); Wimmera Ri., upstream, Horsham, 36°42'S, 142°13'E, 10 Nov. 1987 (C.200854); Wimmera Ri., upstream from the McKenzie Ri., S of Horsham, 36°44'S, 142°10'E, Nov. 1986–1987 (C.201416, C.200855); Glenelg Ri., 37°09'S, 141°51'E, 3 June 1994 (C.203998); *South Australia* Port Pirie, 33°11'S, 138°01'E 1905, 1958 (SAM D.55, D.11931); River Broughton, Koolunga, 33°35'S, 138°20'E (SAM D.11956); Morgan-Whyalla pipeline, 34°02'S, 139°40'E, 22 Aug. 1958 (SAM D.65); Wakefield Ri., 10 miles W of Riverton, 34°08'S, 138°28'E (SAM D.11939); Wakefield Ri. at Robins Crossing, E of Balaklava, 34°09'41"S, 138°34'06"E, 10 June 1994 (C.203033); Light Ri. at Mirgays Waterhole, 34°20'S, 139°00'E, 25 May 1999 (C.405557); Torrens Ri. near Tepleys Hill Rd.

Bridge, Fulham, Adelaide, 34°55'54"S, 138°31'02"E, 28 Apr. 1980 (C.200858); Murray Ri., Murray Bridge, 35°07'18"S, 139°16'53"E, Sept. 1981 (C.200857); Rodwell Cr. tributary of Bremer Ri., Woodchester, 35°12'S, 138°57'E, 25 Apr. 1994 (C.410922); Murray Ri. at Tailern Bend, 35°15'30"S, 139°27'08"E (SAM); Angas Ri., Strathalbyn, 35°16'S, 138°54'E (SAM); Lake Alexandrina, 35°25'S, 139°20'E (SAM D.56); Point McLeay, Lake Alexandrina, eastern side, 35°31'01"S, 139°07'59"E (SAM D.11937).

Diagnosis

Shell 1.37–3.31 mm in height, 1.18–2.82 mm in width, broadly conical; sutures slightly to moderately impressed; body whorl with weak to well developed keel; umbilicus partially open to narrow. Operculum yellow, with 3–5 weakly developed pegs on inner side.

TABLE 1. Shell measurements for *Posticobia* species. Note: operculum either missing or broken in sample of *P. norfolkensis* shells measured.

	SH	SW	AH	BW	CV	TW	OL	OW	OSL	OSW
<i>P. brazieri</i> (n = 337)										
Minimum	1.37	1.18	0.68	1.08	0.10	2.25	0.65	0.51	0.06	0.03
Maximum	3.31	2.82	1.52	2.42	0.32	4.30	1.47	1.06	0.57	0.40
Median	2.47	1.98	1.17	1.87	0.19	3.30	1.04	0.81	0.32	0.18
Mean	2.45	1.97	1.17	1.85	0.19	3.32	1.04	0.81	0.33	0.19
SD	0.35	0.26	0.16	0.24	0.04	0.32	0.14	0.10	0.08	0.06
<i>P. ponderi</i> (n = 30)										
Minimum	1.68	1.41	0.82	1.27	0.14	2.55	0.77	0.64	0.17	0.07
Maximum	2.60	1.98	1.20	1.85	0.28	3.75	1.08	0.90	0.35	0.19
Median	2.22	1.69	1.03	1.66	0.21	3.20	0.94	0.75	0.26	0.12
Mean	2.19	1.71	1.04	1.63	0.21	3.17	0.93	0.74	0.26	0.12
SD	0.18	0.12	0.09	0.12	0.03	0.24	0.07	0.06	0.05	0.03
<i>P. norfolkensis</i> (n = 20)										
Minimum	2.11	1.91	1.07	1.78	0.18	2.65				
Maximum	2.71	2.35	1.37	2.15	0.35	3.50				
Median	2.41	2.06	1.26	1.92	0.25	3.05				
Mean	2.39	2.09	1.26	1.93	0.24	3.07				
SD	0.15	0.11	0.07	0.09	0.04	0.21				

Description

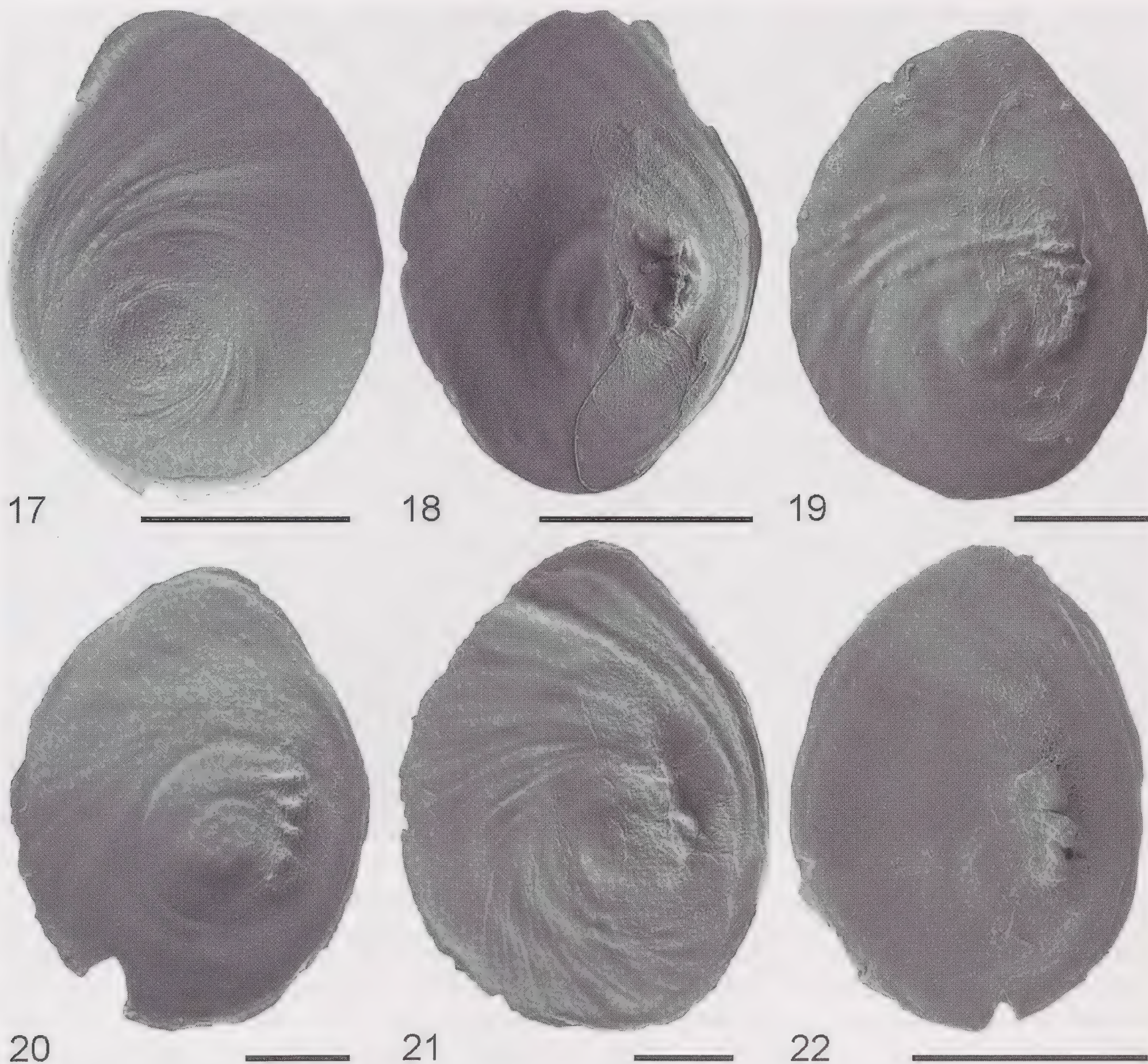
Shell (Figs. 2–4, 7–10) – Shell 1.37–3.31 mm in height, 1.18–2.82 mm in width, broadly conical in shape; spire of average height, outline convex; sutures slightly to moderately impressed. Aperture 0.68–1.52 mm in height, oval and not disjunct from the last whorl. Teleoconch of 2.25–4.30 convex whorls; body whorl 1.08–2.42 mm in height; last whorl convex, weakly to strongly keeled. Teleoconch sculpture smooth, with fine to coarse growth lines. Inner lip of aperture firmly adhering to parietal wall. Outer lip weakly to heavily thickened, lacking an external varix, not reflected. Umbilicus partially open to narrow in adults, narrowly open in juveniles. Colour opaque, yellowish-brown, periostracum thin and may impart darker colour. Protoconch of about 0.85–1.30 whorls; sculptured with dense, irregular shallow pits. See Table 1 for the mean, median and standard deviation of shell dimensions.

Operculum (Figs. 17–20) – Ovate, thin, flat, yellow, horny, paucispiral, with eccentric nucleus, 0.65–1.47 mm in length and 0.51–1.06 mm in width. White smear 0.06–0.57 mm in length,

0.03–0.40 mm in width, 3–5 weakly developed pegs on inner side. Table 1 provides mean, median and standard deviation of opercular dimensions.

Radula (Figs. 23, 24) – Central teeth with 4–5 lateral cusps, sharply pointed and about 2 times longer than adjacent cusps; 3–4 pairs of basal cusps; basal tongue U-shaped, just protruding past lateral edge. Lateral teeth: with 4–5 cusps on each side, sharply pointed and about 2 times longer than adjacent cusps; basal projection U-shaped, lateral flange longer than cutting edge. Inner marginal teeth with 21–31 cusps. Outer marginal teeth with 25–35 cusps.

External Features – Animal pigmentation variable, from weakly to well developed (grey to black), cephalic tentacles long, slender, slightly tapering, with narrow, median-dorsal unpigmented line (corresponding to line of dorsal cilia). Snout (Fig. 27) with some cilia dorsally, with narrow, well-developed band laterally and latero-dorsally just behind labia. Tentacles with well-developed, mid-dorsal (Fig. 28) and two ventro-lateral (Fig. 29) strips of cilia.

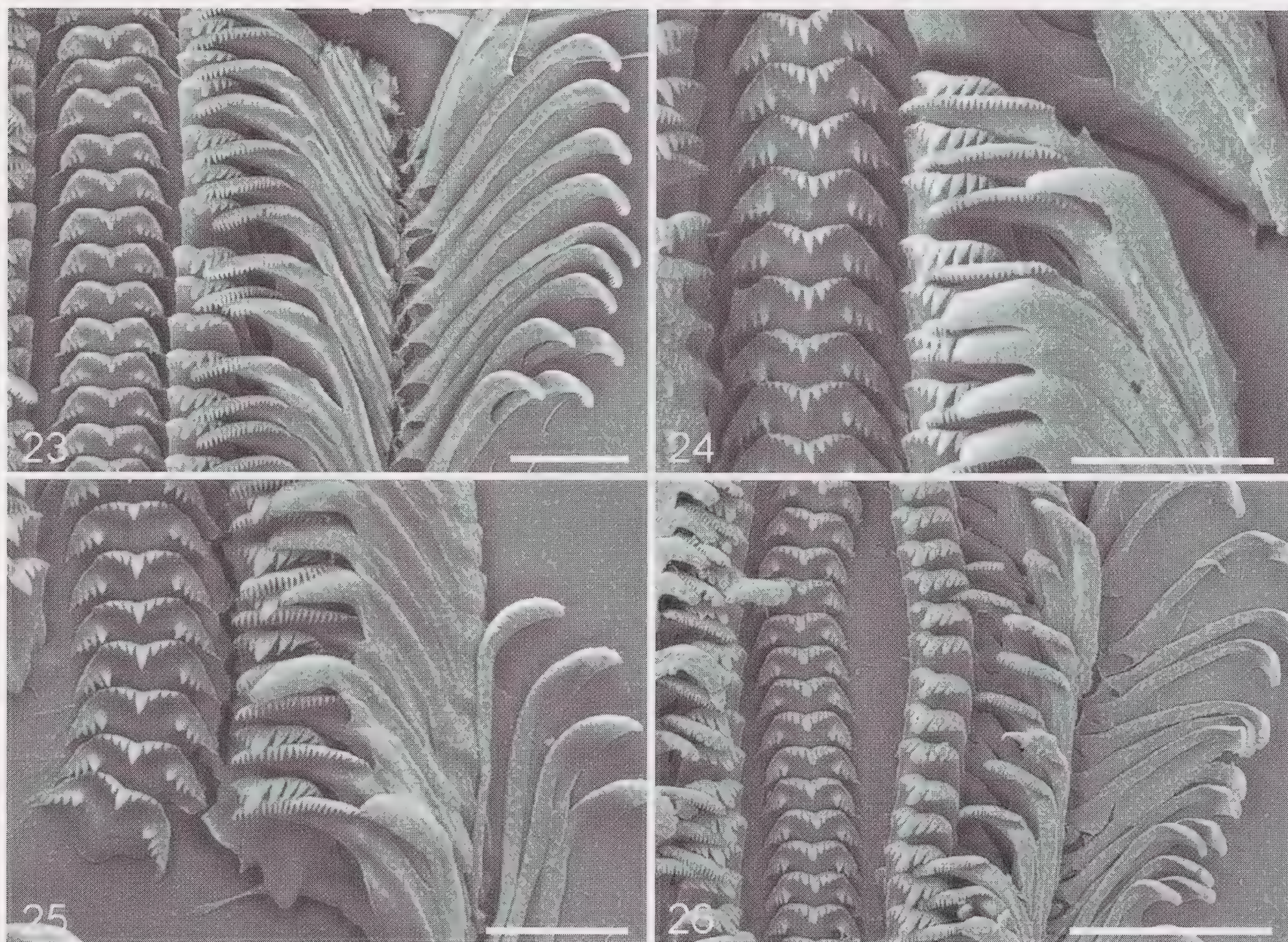


FIGS. 17–22. Opercula of *Posticobia* species. FIGS. 17–20: *P. brazieri*; FIGS. 17, 18: North bank of Clarence River, Grafton, New South Wales; FIG. 17: Outer side; FIG. 18: Inner side; FIG. 19: Mungo Brush, Myall Lakes, New South Wales; FIG. 20: Roper River, Elsie Park, Northern Territory; FIG. 21: *P. ponderi* Mulligan Springs, Lake Callabonna, South Australia; FIG. 22: *P. norfolkensis* Norfolk Island, New South Wales. Scale bars A, B, D, I = 0.5 mm; C, E–H = 0.2 mm.

Mantle Cavity – Ctenidium with 20–32 triangular filaments, width at widest point 0.12–0.39 mm, apices near right side, posterior end abutting pericardium. Osphradium 0.25–0.66 mm in length, white, elongately oval, located between posterior end and middle of ctenidium. Hypobranchial gland inconspicuous to well developed, partly to completely covering rectum. Rectum straight or with weakly developed arch (arch more developed in males). Visceral coil: Renal organ extends forward ca. 1/3–1/2 into pallial cavity, orientated longitudinally. Renal gland 0.34–0.72 mm in length, 0.16–0.34 mm in width. Pericardium more than 1/2 in pallial roof.

Stomach (Fig. 31) – Stomach 0.33–0.74 mm in length; style sac 0.22–0.67 mm in length, with very small to small gastric caecum 0.02–0.17 mm in length.

Male Genital System (Figs. 30, 32, 33) – Testis occupying about 1.0–1.5 whorls. Seminal vesicle beneath anterior 1/4 to 1/2 of first whorl of testis behind stomach; loosely to tightly coiled over stomach; conspicuously coiled on both digestive gland and testis behind stomach. Prostate gland (Fig. 32) 0.40–0.73 mm in length, 0.19–0.34 mm in width, about 1/3 to 2/3 in pallial roof, kidney-shaped, oval



FIGS. 23–26. Radulae of *Posticobia* species. FIGS. 23, 24: *P. brazieri*; FIG. 23: North bank of Clarence River, Grafton, New South Wales; FIG. 24: Mungo Brush, Myall Lakes, New South Wales; FIG. 25: *P. ponderi* Mulligan Springs, Lake Callabonna, South Australia; FIG. 26: *P. norfolkensis* Norfolk Island, New South Wales. Scale bars A, C, F = 50 µm; B, D, E = 20 µm.

to compressed-oval in section. Pallial vas deferens flush with surface of neck, slightly to strongly undulating from prostate gland to base of penis. Penis (Figs. 30, 33) unpigmented, distal part short, tapering, base broad, creased (when at rest). Penial duct strongly undulating in base and straight in distal portion of penis. Penis located just to right of midline, 0.28–0.56 mm behind right eye.

Female Genital System (Figs. 34, 35) – Ovary occupying about 1.00–1.40 whorls. Coiled oviduct with initial U-shaped bend orientated obliquely backwards; initial loop high to medium; proximal part simple; distal part straight or with one bend distal to seminal receptacle. Coiled oviduct and bursal duct joining just behind pallial wall, with oviduct joining bursal duct from right side. Oviduct straight, before joining with bursal duct. Bursa copulatrix 0.27–0.55 mm in length, 0.17–0.33 mm in width; bursal duct 0.04–0.12 mm in length, 0.07–0.15 mm in

width, parallel sided, straight. Seminal receptacle located on or near anterior edge of bursa copulatrix to towards middle of inner wall of bursa copulatrix. Seminal receptacle 0.09–0.22 mm in length, 0.06–0.13 mm in width, pyriform in shape to a narrow sac with short duct. Rectum overlapping both albumen and capsule glands. Albumen gland 0.31–0.51 mm in length, 0.22–0.43 mm in width, and about 1/2 to 2/3 of albumen gland in front of posterior pallial wall. Capsule gland 0.34–0.90 mm in length, 0.18–0.35 mm in width, with anterior end tapering to blunt, oval to compressed oval in section, with distinct glandular zones. Ventral channel indistinct to distinct, with indistinct to moderate sized muscular vestibule. Genital opening small to medium in length, overlapping anterior end of capsule gland.

Egg Capsules – Egg capsules small, 0.30–0.40 mm in diameter, hemispherical in shape, contain a single egg and usually a greenish-yel-

low colour. They are found attached to various substrata, such as sand grains and vegetation or, rarely, attached to the shell of other individuals or other molluscs. Egg capsules have been found in most samples collected during the length of this project. From observations based on a small colony maintained for most of 1993, it appears that *P. brazieri* breeds year around, with a spring/summer peak. The rate of egg production is unknown. However, based on observations of a single captive female, it could be one egg capsule per day. In contrast, Oswald et al. (1991) found that the European spring-dwelling hydrobiid *Bythinella dunkeri* (Frauenfeld, 1857) produced about one egg capsule a week. Longevity is unknown. However, based on laboratory observations, it is at least a year.

Distribution

Found mainly along the coastal areas of New South Wales and Queensland, with scattered populations in western Victoria, South Australia, and the Northern Territory (Fig. 1). There is a large gap in distribution from Sydney, New South Wales, south through to far western Victoria. A large number of sites have been sampled throughout the area over many years, revealing numerous described and undescribed species of *Austropyrgus* and *Victodrobia* Ponder & Clark, 2003, only. The gap between the Northern Territory sites and the Queensland sites is, however, relatively poorly sampled, and further sampling in the region should reveal additional populations of *Posticobia*.

Remarks

The shell morphology of *Amnicola positura* is very similar to that of *P. brazieri*, and Brazier (1889) was the first to recognise this and has been followed in this study. Smith (1992) was the first to synonymise *P. chena* with *P. brazier*, and this is supported by this study. According to notes with the original sample of *P. chena*, it came from the stomach contents of a duck shot on Chichester Dam. However, no specimens of *Posticobia* have ever been found at the dam, and the other molluscan taxa present in the sample – *Tatea rufilabris* (Adams, 1862), *Ascorhis tasmanica* (Martens, 1858) and *Fluviolanatus subtorta* (Dunker, 1857) – are all common, widespread species found in brackish conditions. These taxa and a morphologically similar form of *Posticobia* are representative of the fauna and conditions

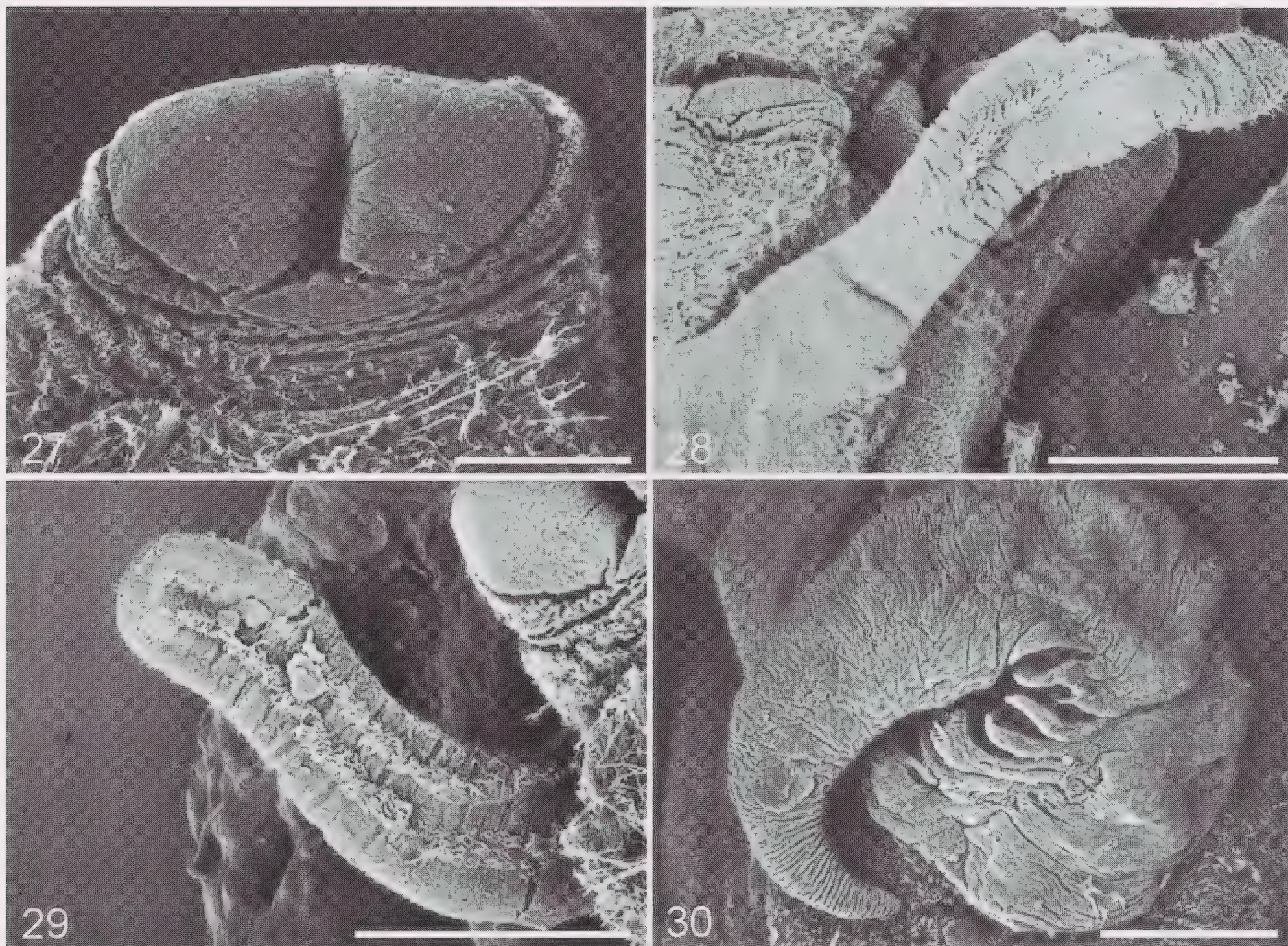
found nearby at the Myall Lakes. These snails are smaller, than typical *P. brazieri* found to the north, south and west of the lakes, including at the Myall River at Bulahdelah, some 17 km by river west of the lakes. Besides the size difference the other major difference is the degree of keel development, which varies from very weak to obvious.

Posticobia brazieri can be easily distinguished from all other known Australian hydrobiids by its shell shape and the presence of a keel in almost all populations. When *P. brazieri* is found in freshwater habitats, it is usually the only hydrobiid present. However, it is known to be sympatric with *Fluvidona petterdi* (Smith, 1882) at Lismore, northern New South Wales, and at least four undescribed species of *Fluvidona* and *Jardinella* in northern New South Wales and southern Queensland. It occurs with *Austropyrgus macropus* Clark et al., 2003, in a few localities in southeastern South Australia (Fig. 1) and with the introduced hydrobiid *Potamopyrgus antipodarum* (Gray, 1843) in several sites in Sydney and Newcastle, New South Wales, and southeastern South Australia. In estuarine conditions, such as the Myall Lakes, central New South Wales, it can be found with the estuarine hydrobiids *Ascorhis tasmanica* and *Tatea rufilabris*.

Discriminant function analysis using only shell measurements (SH, SW, AH, BW, CV, TW) separated all three taxa (Wilks' lambda = 0.632; approx. F = 19.619, df = 10,760 p-tail < 0.000), with 227 of 337 specimens of *P. brazieri* correctly identified, while 23 were misidentified as *P. norfolkensis* and 87 as ***P. ponderi*** n. sp. for an overall classification rate of 67%.

Given the range of shell variation observed in *P. brazieri* as currently recognised, it is possible that future molecular and anatomical studies may reveal additional taxa. However, Haase (2003) observed that the shell shape of populations of *Potamopyrgus antipodarum* from two streams on the North Island of New Zealand was correlated with flow, with shell size increasing downstream. A similar phenomenon seems to be occurring in *P. brazieri* with both shell size and keel development. For example, in low flow situations, such as Ban Ban Springs in southern Queensland and the Myall Lakes in New South Wales, the shells tend to be a little smaller and keel development tends to not be as conspicuous, whereas in the larger streams and rivers, the shells tend to be larger and have more prominent keels.

Posticobia brazieri is known to act as the intermediate host for at least ten species of



FIGS. 27–30. Details of the snout, cephalic tentacles and penis from critical point dried material of *Posticobia brazier*, NW of Gympie, Queensland (AMS). FIG. 27: Ventral view of snout; FIG. 28: Dorsal view of right cephalic tentacle; FIG. 29: Ventral view of right cephalic tentacle; FIG. 30: Dorsal view of penis. Scale bars B, C = 200 μ m; A, D = 100 μ m. (Illustrations used with the permission of W. F. Ponder, Australian Museum).

fish trematodes (Cribb, 1985, 1986, 1988a, b). However, the actual number appears to be considerably higher (T. Cribb, personal communication). Infected individuals of *Posticobia* are typically much larger than uninfected individuals and virtually always have very immature / undeveloped reproductive organs, in both males and females (this study).

***Posticobia ponderi* n. sp.**
Figures 1, 5, 11, 15, 21, 25, 36

Diagnosis

Shell small, 1.68–2.60 mm in height, 1.41–1.98 mm in width, conical; body whorl smooth, convex; sutures deeply impressed; keel absent; umbilicus narrow. Operculum with 1–2 weakly developed pegs. Central teeth with 4–5 lateral cusps and 4 pairs of basal cusps.

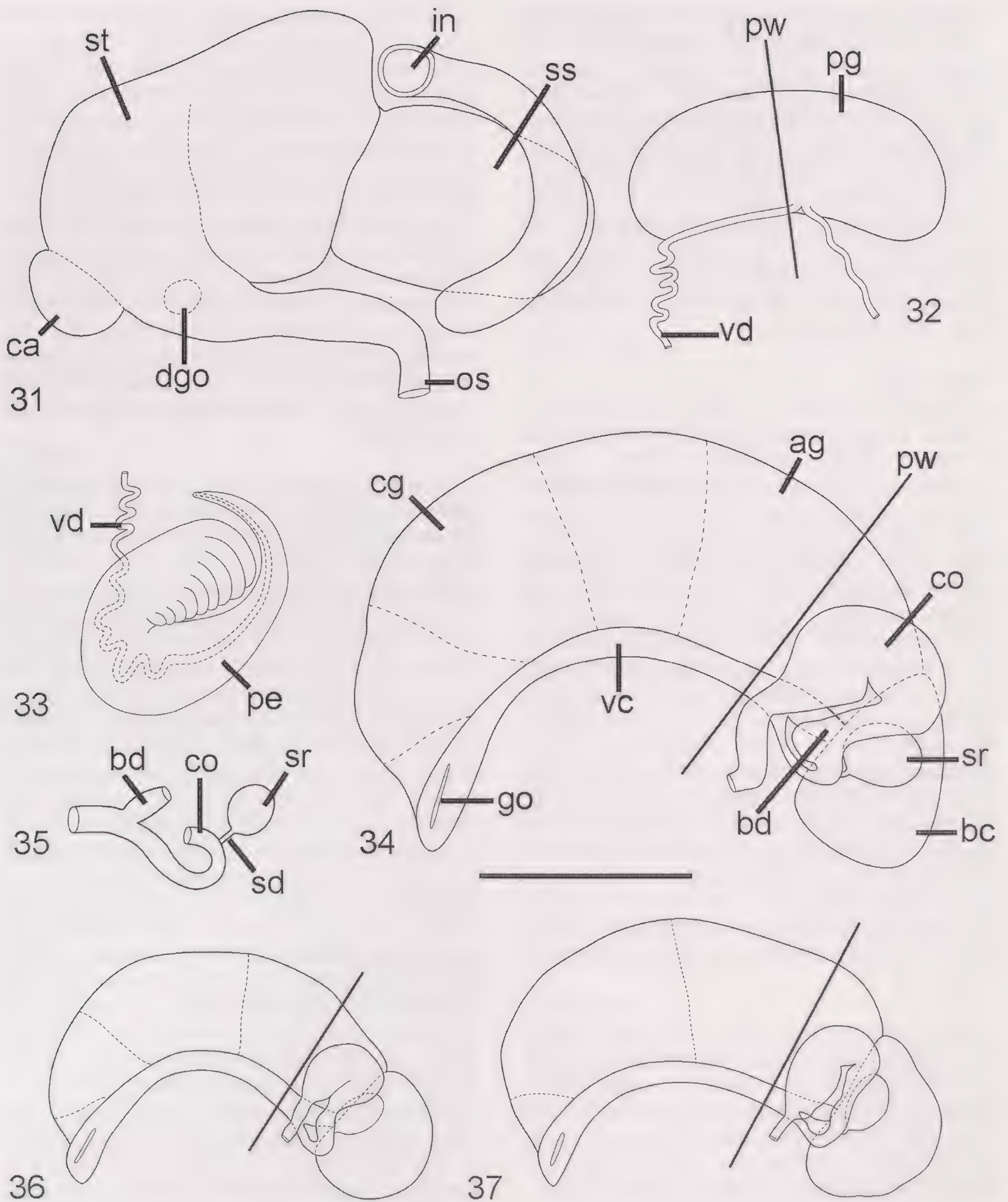
Type Material

Holotype C.461157, paratypes C.203032 (many).

Type Locality

Outflow of small spring, Mulligan Springs, on western edge of Lake Callabonna, 40.1 km E of the Wooltana-Moolawatanna Rd., 29°43'41"S, 139°58'22"E, South Australia, Australia, 0 m, 28 May 1993, in 5–10 mm of water, amongst small sedges, S. A. Clark.

Additional Paratypes – South Australia spring at N end of "Callabonna Peninsula", Lake Callabonna, 29°43'S, 139°58'E, 19 May 1982 (C.200877); spring on S side of Mulligan Springs, Lake Callabonna, 29°44'01"S, 139°58'E, 20 May 1982 (C.200874); spring on S side of Mulligan



FIGS. 31–37. Illustrations of the stomach, male and female genitalia of *Posticobia* species. FIGS. 31–36: *P. brazieri* north bank of the Clarence River, Grafton, New South Wales; FIG. 31: Stomach; FIG. 32: Prostate gland viewed from the left side; FIG. 33: Penis; FIG. 34: Glandular oviduct viewed from the left side; FIG. 35: Expanded view of the oviduct and seminal receptacle; FIG. 36: Mungo Brush, Myall Lakes, New South Wales; glandular oviduct viewed from the left side *P. chena*; FIG. 37: *P. ponderi* Mulligan Springs, Lake Callabonna, South Australia; glandular oviduct viewed from the left side. Scale bar = 0.5 mm.

Springs, near Lake Callabonna, 29°44'01"S, 139°58'01"E, 20 May 1982 (C.200875); southern most spring of Mulligan Springs, Lake Callabonna, 29°44'01"S, 139°58'01"E, 20 May 1982 (C.200876); Mulligan Springs, Lake Callabonna, 29°44'S, 139°58'E, 20 May 1982 (C.200873); spring, 200 m WSW of stn. C209F at N end of "Callabonna Peninsula", Lake Callabonna, 29°45'01"S, 140°00'E, 19 May 1982 (C.200878); spring with pool and swamp, at N end of "Callabonna Peninsula", Lake Callabonna, 29°45'01"S, 140°00'E, 19 May 1982 (C.200879).

Description

Shell (Figs. 5, 11) – Shell 1.68–2.60 mm in height, 1.41–1.98 mm in width, conical in shape; spire of average height, outline convex; sutures deeply impressed. Aperture 0.82–1.20 mm in height, oval, not disjunct from last whorl. Teleoconch of 2.55–3.75 convex whorls, body whorl 1.27–1.85 mm in height, last whorl evenly convex, keel absent. Teleoconch sculpture smooth, with fine growth lines. Inner lip of aperture firmly adhering to parietal wall. Outer lip heavily thickened, lacking an external varix, not reflected. Umbilicus small, narrow in adults, narrowly open in juveniles. Colour opaque, yellowish-brown, periostracum thin, may impart darker colour. Protoconch (Fig. 15) of about 1.25–1.30 whorls; sculptured with dense, irregular shallow pits. Table 1 provides the mean, median and standard deviation of shell dimensions.

Holotype dimensions: SH – 2.18 mm, SW – 1.64 mm, AH – 0.98 mm, BW – 1.64 mm, TW – 3.5.

Operculum – Ovate, thin, flat, yellow, horny, paucispiral, with eccentric nucleus, 0.84–1.08 mm in length, 0.65–0.90 mm in width. White smear 0.17–0.35 mm in length, 0.07–0.19 mm in width; 1–2 weakly developed pegs on inner side. Table 1 provides the mean, median and standard deviation of opercular dimensions.

Radula (Fig. 25) – Central teeth with 4–5 lateral cusps, sharply pointed and about 2 times longer than adjacent cusps; 4 pairs of basal cusps; basal tongue U-shaped, just protruding past lateral edge. Lateral teeth with 5 cusps on each side, sharply pointed, about 2 times longer than adjacent cusps; basal projection U-shaped, lateral flange longer than cutting edge. Inner marginal teeth with 23–24 cusps. Outer marginal teeth with 27–30 cusps.

Head-Foot – Animal unpigmented.

Mantle Cavity – Ctenidium with 19–24 triangular filaments, width at widest point 0.15–0.20 mm, apices near right side, posterior end abutting pericardium. Osphradium 0.22–0.36 mm in length, white, elongately oval, located between posterior end and middle of ctenidium. Hypobranchial gland inconspicuous to well developed, partly to completely covering rectum. Rectum straight or with weakly developed arch (arch more developed in males). Visceral coil: Renal organ extending forward ca. 1/2 into pallial cavity, orientated longitudinally. Renal gland 0.28–0.43 mm in length and 0.17–0.27 mm in width. Pericardium more than 1/2 in pallial roof.

Stomach – Stomach 0.49–0.67 mm in length, style sac 0.29–0.40 mm in length, with very small gastric caecum 0.06–0.07 mm in length.

Male Reproductive System – Testis occupying about 1.0–1.3 whorls. Seminal vesicle beneath anterior 0.30–0.40 of first whorl of testis behind stomach, loosely to tightly coiled over stomach; conspicuously coiled on both digestive gland and testis behind stomach. Prostate gland 0.40–0.49 mm in length, 0.17–0.18 mm in width, about 1/2 in pallial roof, kidney-shaped, oval to compressed-oval in section. Pallial vas deferens flush with surface of neck and slightly undulating at prostate gland, strongly undulating between prostate and base of penis. Penis unpigmented, distal part short, tapering, base broad, creased (when at rest). Penial duct strongly undulating in base, straight in distal portion of penis. Penis located just to right of midline, 0.28–0.34 mm behind right eye.

Female Reproductive System (Fig. 36) – Ovary occupying about 0.75–1.00 whorls. Coiled oviduct with initial U-shaped bend orientated obliquely backwards; initial loop medium, proximal part simple; distal part straight to seminal receptacle. Coiled oviduct and bursal duct joining just behind pallial wall, with oviduct joining bursal duct from right side. Oviduct straight, before joining with bursal duct. Bursal duct 0.04–0.08 mm in length, 0.10–0.11 mm in width, parallel sided, straight. Bursa copulatrix 0.22–0.36 mm in length, 0.16–0.25 mm in width. Seminal receptacle located on or near anterior edge of bursa copulatrix to towards middle of inner wall of bursa copulatrix. Seminal receptacle 0.09–0.13 mm in length, 0.07–0.12 mm in width, pyriform in shape to a narrow sac with

short duct. Rectum overlapping both albumen and capsule glands. Albumen gland 0.22–0.34 mm in length, 0.22–0.29 mm in width, more than 1/2 of albumen gland in front of posterior pallial wall. Capsule gland 0.31–0.45 mm in length, 0.21–0.28 mm in width, with anterior end tapering to blunt, oval to compressed-oval in section, with distinct glandular zones. Ventral channel indistinct to distinct, with indistinct to moderate-sized muscular vestibule. Genital opening small to medium in length, overlapping anterior end of capsule gland.

Egg Capsules – Egg capsules very similar in size and shape to those observed for *P. brazieri* and found on similar substrata.

Distribution

Known from a number of small springs that make up the Mulligan Springs complex on the western edge of Lake Callabonna. The species is abundant but sporadically distributed among the springs in two discreet areas.

Etymology

Named for my friend and mentor Winston Ponder, in recognition of his extensive research on Australian molluscs, particularly the family Hydrobiidae over more than 30 years. He was the first to find the Mulligan Springs populations and highlighted their distinctiveness to the author.

Remarks

The species is currently known only from a small number of springs, with additional surveys in the area are likely to find additional populations. *Posticobia ponderi* is generally smaller than the other two species; it only has 1–2 weakly developed pegs on the inner side of the operculum and the prostate gland is half in the pallial cavity. However, probably the most distinctive character is the total lack of a keel or shoulder on the body whorl of *P. ponderi* compared to the other species. *Posticobia ponderi* is most similar in terms of general shell shape to populations of *P. brazieri* from the Roper River in the Northern Territory (Figs. 10, 11).

Discriminant function analysis using only shell measurements (SH, SW, AH, BW, CV, TW) separated all three taxa (Wilks' lambda = 0.632; Approx. F = 19.619, df = 10,760 p-tail < 0.000) with only 6 of 30 specimens of *P. ponderi* misidentified as *P. brazieri* for an overall classification rate of 80%.

Posticobia norfolkensis (Sykes, 1900)

Figures 1, 6, 12, 16, 22, 26

Paludestrina norfolkensis Sykes, 1900: 146, pl. 13, fig. 14, Norfolk Island.

Posticobia norfolkensis – Ponder, 1981: 18–28, fig. 2, 1–5; Smith, 1992: 54.

Type Material

Syntypes NHML 1856.10.27.94 (32 specimens).

Type Locality

Norfolk Island, about 1,400 km E of Brisbane, New South Wales, Australia.

Material Examined

New South Wales Bumbora Beach, Norfolk Island, 29°03'40"S, 167°57'30"E, 1909 (C.30992); Norfolk Island, 29°03'30"S, 167°57'30"E (C.34522); Bumbora, Norfolk Island, 29°03'40"S, 167°57'30"E, 4 Aug. 1913 (NMNZ FM20070).

Diagnosis

Shell 1.70–2.71 mm in height, 1.50–2.35 mm in width, ovate; sutures moderately impressed; last whorl sub-shouldered, convex, keel absent; umbilicus narrow. Protoconch of about 1.25 whorls, sculptured with sparsely distributed irregular shallow pits. Operculum yellow? with 3 weakly developed pegs. Central teeth with 5 lateral cusps, 4 pairs of basal cusps.

Description

Shell (Figs. 6, 12) – Shell 1.70–2.71 mm in height, 1.50–2.35 mm in width, ovate in shape, spire of average height, outline convex, sutures moderately impressed. Aperture 0.89–1.37 mm in height, oval, not disjunct from the last whorl. Teleoconch of 2.40–3.50 convex whorls, body whorl 1.38–2.15 mm in height, last whorl sub-shouldered, convex, keel absent. Inner lip of aperture slightly separated from parietal wall. Outer lip heavily thickened, lacking external varix, not reflected. Teleoconch sculpture smooth, with fine growth lines. Umbilicus narrow. Colour yellowish-brown, periostracum thin. Protoconch (Fig. 16) of about 1.25 whorls, sculptured with sparsely distributed, irregular shallow pits. Table 1 presents the mean, median and standard deviation of shell dimensions.

Operculum (Fig. 22) – Ovate, thin, flat, yellow, horny, paucispiral, with eccentric nucleus, with up to 3 weakly developed pegs on inner side.

Radula (Fig. 26) – Central teeth with 5 lateral cusps, 4 pairs of basal cusps; sharply pointed, about 2 times longer than adjacent cusps; basal tongue U-shaped, just protruding past lateral edge. Lateral teeth with 5 cusps on each side, sharply pointed, about 2 times longer than adjacent cusps; basal projection U-shaped, lateral flange longer than cutting edge. Inner marginal teeth with 24–26 cusps. Outer marginal teeth with 35–38 cusps.

Details of the living animal, its internal anatomy and egg capsules unknown.

Distribution

Known only from the type locality (Fig. 1).

Remarks

Due to the limited material available of *P. norfolkensis*, it is tentatively recognised as a separate species of *Posticobia*. Unfortunately, this species is believed to be extinct, as a considerable effort was made to recollect it without success in June 1979 by Winston Ponder and November 1997 by Robert Varman. Habitat destruction due to human intervention and damage caused by grazing cattle were indicated as the major contributors to the demise of this species (Ponder, 1981). However, R. Varman has suggested that a combination of clearing, grazing, and a devastating flood locally known as “The Flood”, which occurred around 1936, may have significantly affected the species’ survival (personal communication).

Another possibility is that the species was not actually endemic to Norfolk Island but may represent a transient population of *P. brazieri* from the Australian mainland, as the only known material of this species was collected from a small stream flowing through what is now known as Bumbora Reserve.

Discriminant function analysis using only shell measurements (SH, SW, AH, BW, CV, TW) separated all three taxa (Wilks’ lambda = 0.632; ca. $F = 19.619$, $df = 10,760$ p -tail < 0.000), with only 1 of 20 specimens of *P. norfolkensis* misidentified as *P. brazieri* for an overall classification rate of 95%.

Posticobia sp.

?*Austropyrgus* species, Clark et al., 2003: 104.

Remarks

Clark et al. (2003) illustrated (Fig. 63: A1–A3) specimens of a population collected from a sink-hole near Mt. Gambier, South Australia, which are considered to be an unusual ecological variant of *P. brazieri*. These specimens are typical of *P. brazieri*, except that the body whorl has separated from the rest of the shell. The population co-occurs with *Austropyrgus vastus* Clark et al., 2003, and to date no living material of either form has been located, and thus the true affinities of this population remain unclear.

DISCUSSION

Posticobia is genetically and anatomically closely related to *Austropyrgus* (Clark, 1997; Perez et al., 2005). Despite this, the two genera show markedly different patterns of speciation. *Posticobia* has one very wide ranging species, with two additional species occurring in isolated populations on the eastern and western peripheries of the distribution of the genus, whereas *Austropyrgus* has over 70 described species and many more undescribed, the majority of which, have small to very small ranges (Clark et al., 2003). This is probably due in part to the differing preferred habitats for the two genera. A similar situation is seen with the New Zealand genus *Potamopyrgus*, with one wide ranging species and a small number of additional species with very narrow ranges (Winterbourn, 1970; Haase, 2008).

Posticobia tends to live in large coastal rivers, streams and lakes (except for *P. ponderi* very small springs), which, are relatively open and allow access to such passive dispersal agents as birds (Boag, 1986; Ribi, 1986), fish (Haynes et al., 1985), and floods. *Austropyrgus* tends to live in small streams and springs with closed canopies and little access to passive dispersal agents (Ponder et al., 1994; Ponder & Colgan, 2002). Allozyme genetic variation both within and among populations is considerably higher in *Austropyrgus* than in *Posticobia* (Clark, 1997), implying that gene flow is higher in *Posticobia*, which appears to be related to habitat differences (Ponder et al., 1994). Thus, predominantly due to habitat preference and restricted gene flow, *Austropyrgus* is much more speciose, and species have much more restricted distributions than *Posticobia* (Clark et al., 2003).

An interesting aspect of the distribution of *Posticobia* is the large gap between the popu-

lations found in Sydney, New South Wales, to those found in far western Victoria and south-eastern South Australia (Fig. 1). Within this region, populations of *Austropyrgus* are found in virtually all suitable streams from southern New South Wales south and west along the coastal regions to southeastern South Australia, with some streams and springs having up to four sympatric species and frequently occur in very high densities (Clark et al., 2003). There are a few possible explanations for this including: (i) that *Posticobia* is currently expanding its range, especially into western Victoria and southeastern South Australia, as the known populations from this general area are relatively widely scattered (although this could just be an artifact of sampling effort); (ii) that the more isolated populations of *Posticobia* in South Australia and Victoria are remnant populations of a single formerly more widespread species that has undergone range contraction via recent extinction events due to such factors as habitat loss/modification or increased aridity in the intermediate areas; (iii) that these isolated population represent additional cryptic species; (iv) that *Posticobia* is essentially out-competed by *Austropyrgus*; this is based on limited observations in South Australia where the two genera are sympatric, *P. brazieri* was less numerous than *A. macropus* at a site on the Wakefield River, N of Adelaide; or (v) that as the invasive New Zealand hydrobiid *Potamopyrgus antipodarum* continues to expand its range in southeastern Australia, it can more rapidly colonise new/available habitats than can *Posticobia*. Future molecular studies could provide useful information towards resolving hypotheses (i–iii). However, hypotheses (iv–v) are more speculative and are based on limited observations, but nonetheless it would be interesting to determine if there are any competitive interactions between sympatric species in different genera or indeed between sympatric species in the same genus. I know of no studies of this kind for native Australian hydrobiids, although there has been some work looking at interactions between *Potamopyrgus antipodarum* stream disturbance and native aquatic invertebrates (Schreiber et al., 2003).

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